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THE UNIVERSE

In Brief, as I Understand It, *with a* Description of Earth *and* Development of Man.

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By LYSANDER SALMON RICHARDS, *Author of* "Vocophy," and "Breaking Up; or, the Birth, Development and Death of our Planet in Story."

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PREFACE.

The authorities I shall have occasion to use during my brief description of the Earth and Universe will be mentioned at this time, and are as follows: Silliman, Grove, Dana, Proctor, Burritt, Mayer, Tyndall, Bakewell, Helmholtz, Denton, Reclus, Farraday, Shaler, Geyot, Niles, Humboldt, Johnson, Guillemin, Russell, Laplace, Nichols, Darwin, Lardner, Wood, Young, Gore, Clerke, Lockyer, etc.

In describing the starry vault and the laws and forces of the universe, we must needs also dwell at some length upon the origin and construction of our own planet, the processes of development, both organic and inorganic bodies, that we may better appreciate the action of laws universal by which all nature through space exists and operates. Our method in attempting to popularize these facts will be to substitute for technical, scientific formula, common, intelligible terms and phrases, that the most unpracticed

thinker may with ease comprehend them; for just in proportion to the clear understanding of nature, both here and throughout space, just so rapidly will all mysteries vanish, and the fact be established that the universe exists, develops, and moves in obedience to natural law. In this description it will be unavoidably necessary to repeat now and then a sentence or thought published in my former work on the "Birth, development and death of our planet."

L. S. RICHARDS.

MARSHFIELD HILLS, MASS., U. S. A., 1900.

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CHAPTER I.

EARTH'S FORMATION.

Most scientists are agreed in the opinion that the globe which we inhabit originated from a nebula, gaseous mass, similar to the nebula in various stellar constellations, which can easily be seen on a clear night through any small telescope, appearing like a distant cloud; this nebula comprised the entire solar system, with the sun for its center, and its outer edge, Neptune's orbit, being 2,862,000,000 miles distant from the sun, and the diameter of which, some 5,700,000,000 miles, gives us a partial idea of the immense size of the great nebula, gaseous mass, which extended throughout the system mentioned. At last in the process of time, the molecules or particles composing the nebula are disturbed, separation takes place in form of rings, from the central mass, the sun; these rings finally break, and the separate masses of each are attracted toward a centre in the path of each ring, a globe is heaped together, a separate existence is given to every planet in our system at different stages in the progress of the nebula, and each speeds in its orbit around the central mass, the sun. The earth,

the mines of Belgium, at a considerable depth, the heat is so great that no one but miners accustomed to working them can but a moment remain there. In my travels down the deep mines of Nevada and California, it was so hot at 1,500 feet from the surface the perspiration would run in streams from my face. The water at this level was so hot it would be uncomfortable to take a bath in it. In one chamber at this depth it was so hot an egg would boil in the water in fifteen minutes.

The spectroscope—one of the most important aids to science given to man in the 19th century—is an instrument with a prism and three tubes, used by chemists for chemical analysis, and by astronomers for the analysis of the stars. The sun is found to contain sodium, iron, hydrogen, magnesium, copper, zinc, calcium, nickle, etc., same as our planet. The common origin of bodies comprising the solar system is substantiated through spectrum analysis, as most of the elements the earth contains, the entire system possesses. Most of the stars examined contain properties that contribute to the support of life. If then our planet was originally a fiery, liquid, or vapor mass, all manner of forms now upon it, man, beast, trees, rocks, all were one and the same in this seething, universal boiling cauldron. Analyze the grave after the body is entirely decomposed, and the most skillful chemist cannot detect

the faintest trace of the body as distinct from the earth. The muscles of man contain soda; blood, potash and iron; bones, lime and phosphorus; hair, silica; brain, phosphorus and magnesia; the body contains beside, oxygen, hydrogen, carbon, nitrogen, chlorine, albumen, etc., elements common to beasts, plants and soil. The earth is being created to-day, just as rapidly as thousands of years ago. It is yet young, although millions of years old. The crust is very thin—a few miles only—while the diameter of the earth is nearly eight thousand. The interior is constantly solidifying, and in course of millions of years it will undoubtedly become one solid mass. Earthquakes and volcanoes in that distant future can be no more, for the interior fiery fluid no longer exists to produce, through agitation, these phenomena. As this condensation process is continued, the earth from necessity, is diminishing in size; its size at one time is supposed to have been some eighteen hundred times larger than its present dimensions.

CHAPTER II.

EARTH'S SOLIDS.

During the early condensation of our planet, the surface expending more heat than the interior, its condensation was more rapid, and the conversion of its liquid mass into a crust of rock readily effected. Since this formation, fluid masses beneath the crust have been continually ejected at different points of the earth, through the action of volcanoes, and by the same process of condensation, these flowing, molten streams have hardened into rock, generally granite, basalt or trap rock. Thus granite, though belonging to the oldest formation, is constantly being formed, even in our own age; hence it is found, rocks are forming to-day as in the past, and this is not confined to granite, trap or basalt, but sandstones, slates and limestones are being made. The former series are igneous rocks, so-called because they are due to the action of fire or heat; the latter series are sedimentary rocks, simply that they are the result of sediments hardening. Sandstones are made up mostly of siliceous sand, which particles in close contact have gradually been cemented into rock. This is taking place to-day

on some coasts where the sandy deposits lie undisturbed. Slates are composed of clay, the basis of which is alumina; a clay deposit or bed is very common, a thin deposit is often hardned, though very gradually, into slate rock.

The larger part of limestones are the result of organic life, beings once carrying about with them the lime in the form of shells and bone, that now constitute a large amount of huge rocks scattered over the globe. The ocean's bed abounds with shelled animals, both large and small, and when these shells drop off, decomposition in time commences; they drift together, one large mass slowly consolidates, and thus we have a limestone rock. In Addison, New York state, I found stones in walls made up of shells not yet decomposed; the shells retaining their original shape, are cemented together by the lime they contain and thus form a solid rock. A fort in Florida is made of these shell stones; break them and nothing but little shells are seen, cemented together so closely as to enable constructors to build with them. The ocean is actively at work in manufacturing rock to-day as ever, its entire bed is its workshop, and tons upon tons are annually converted into rock. Millions of little shells cover a very small area of the ocean's bed. The great chalk beds of England are composed of myriads of Rhizopod shells,

so small that a microscope is necessary to detect most of them. Through the action of heat, limestone is often crystallized into marble, a carbonate of lime. Another method nature adopts in the manufacture of rock called conglomerate, commonly known as pudding stone. While the work of removing Fort Hill, Boston, was in process some years ago, a deep bed of mixed clay was distinctly seen; scattered through this bed were many stones, evenly distributed. I at once recognized the fact, that this bed—though easily separated with a pick—was rapidly hardening into a conglomerate rock. Each stone was enveloped by sesquioxide of iron, a very necessary ingredient in cementing them into the bed in which they lay. Could this bed have remained undisturbed, time would certainly have effected its consolidation, and Fort Hill been converted into a solid conglomerate rock. In Fulton, New York, I found another hill of conglomerate in process of formation, better formed than at Fort Hill. The little pebbles were already cemented together, and yet not sufficiently strong to withstand a slight pressure of the fingers. A rock is dense and compact just in proportion to the affinity the particles composing it have for each other, and the pressure brought to bear upon them. Steam among rocks is repulsive to cohesion or solidification. In my investigations

down the deep mines of Nevada and California, the intense heat converting the water into vapor and in some instances steam, the sulphates, so-called, (a sulphuret of iron, in combination with gold and silver ore, a solid rock when undisturbed by heat or heated moisture), became so soft and loose at these depths of 1,500 feet that the rock was easily separated by a small pick. The force of cohesion or attraction exerts as great a power in combining the molecules or particles as adhesion. Surrounding all substances there are two forces, attraction and repulsion. Heat excites the repulsive force, and the particles separate. This we saw, in common with every other observer, at the great Boston fire in 1872, when heavy stone granite columns on the opposite side of the street where the fire was raging—thirty or forty feet from the blaze—crumbled to pieces, the cleavage in many instances shelving the rock in a circular form, presenting a shell like stone, with a round ball lying within its hollow, while most of the column was crumbled as fine as gravel. In the absence of heat the force of attraction is obeyed, the molecules draw closer together, and are firmly held by the opposite force, assisted by the force of adhesion. The particles or molecules of rocks or any substance, however compact or solid, are never in immediate contact with each other, the forces mentioned preserve a

space between them, invisible however to the unaided eye. The question is often asked, "Do stones grow?" No! not as plants and animals grow of themselves. Stones sometimes increase in size, as the boys' snow-ball when rolled in the snow, accumulates from without. Some class of deposits accumulate around the stone, and adhere to its surface, and consequently it becomes enlarged. At times rocks partly submerged in large bodies of water, as the ocean, appear to grow, but this illusion is due to the very gradual and unobserved subsidence of the water, which exposes a larger surface of the rock to view. At many places upon the earth's crust there are fissures or crevices extending through the rocky bed, due probably to some internal convulsion; these fissures are often filled by a trap-dike. One of these I have observed in a marked degree in the Quincy granite quarries. A large bed of granite is cut into by said trap-dike, and it is very probable that when the fissure was made a portion of the liquid, molten mass, occupying the earth's interior, was forced up through it and hardened in process of time into a trap-rock. Another excellent specimen of a trap-dike can be seen on an extended scale in the vicinity of the Glades, a shore resort near Nantasket Beach. The color of these rocks or dikes is often dark green, and they are somewhat similar to the com-

mon slate, except coarser grained and rougher, with the touch more of sand stone. In traveling over the immense lava beds of the Pacific slope I was deeply impressed with the extensive laboratories of nature, miles upon miles we journeyed on foot and in teams over these black beds, which were once belched forth from the bowels of the earth in a liquid, paste mass through volcanoes now extinct, and hardening in the course of ages into a solid rock.

CHAPTER III.

FORMATION OF COAL.

Coal was formerly considered a rock; it is now known to be of vegetable origin. In my travels in the coal mines of Pennsylvania, I was fortunate in finding the walls below frescoed, as it were, with fern and other plant impressions, which were convincing of its plant ancestry. In some mines stumps of trees standing erect are found running through several overlying rocky strata. The carboniferous epoch was the great coal-making age. A large portion of the land surface of our globe was covered with vegetation, coal plants the most prominent. The continent at this age was subject to various changes; at times high and dry above the water, and at other periods largely submerged in the ocean, in which condition the plants decayed, forming an extensive bed over the submerged portion of the continent.

While lying in this watery grave, constantly decomposing, settling and becoming more compact, clay, sand and shells were continually washed over it, which covering, prevented to a large extent the carbon escaping from this de-

composing mass, the same as in the manufacture of charcoal, wood is ignited, decomposed, sods or earth are thrown over the decomposing or burning mass, it smothers, the carbon is largely prevented from escape, and charcoal, pure carbon, results. So does the earth, accumulating over the extensive, decomposing coal plant bed, check the escape of carbon and convert the under mass into coal. The continual accumulation of earth over it tends to harden the underlying bed by the constant pressure the earth's weight gives to it. The sand constituting a portion of the earth deposit, in process of time is converted into sandstone, hence a layer of sandstone is above the coal, the clay washed over and deposited on the sand hardens into rock as before described, and we have a layer of argillacious shale; then shells are constantly being washed over the bed, and in course of time are consolidated into limestone. Thus we have in the coal measures, a bed of coal, overlying which a layer of sandstone, another of shale, and another perhaps of limestone. The continent by this time, after the lapse of thousands of years, is again elevated, soil accumulates over these layers described, vegetation starts, and huge plants once more cover portions of the earth; the continent is again submerged, another bed of coal is formed, and the process thus goes on.

In the United States these beds extend through Rhode Island, the central portion of Massachusetts, Pennsylvania, half of Ohio, part of Kentucky, Tennessee, Indiana, Illinois, Michigan, Iowa, Minnesota, Missouri, Kansas, Arkansas, northern part of Texas, and the Rocky mountain region. During this age, the Appalachian range of mountains was elevated, and previous to this revolution all coal was bituminous, but from the disturbance the coal east of the newly elevated range was deprived of its bitumen, and thus converted into hard, anthracite, while as we proceed west of said mountains, the coal grows softer, first semi-bituminous, then bituminous. Through searching investigations by one of our most distinguished geologists, it has been found that coal in Pennsylvania is gradually being made to-day at the rate of one foot in two thousand years. Beds vary from one inch to forty feet in thickness; hence at the same rate of accumulation and solidification the thickest beds in forming must have occupied some eighty thousand years.

In entering a coal mine at Pottsville, Pennsylvania, I saw at a considerable depth nothing but coal about me. Coal above in chambers as large as an ordinary size hall, and coal below, nothing but coal in whatever direction you look, but these upon close investigation were found to be in

layers or beds of varied thickness, but to an ordinary visitor they appeared as one solid compact bed.

CHAPTER IV.

PETRIFIED FOREST.

Our investigations of the wonderful Petrified Forest of California revealed the mysterious workings of nature in a remarkable degree. The trees when first discovered had fallen and buried, but through the exertions of the proprietor the earth was removed, and the trees exposed to view. There are but few trees alive in the forest, but scattered here and there throughout the field lay trees completely petrified. Some show simply the trunks of trees as they lay turned over on the ground; others, trunk, branches and roots as they project from the ground. Some are very large, and others small. One tree measured eleven feet in diameter, and about thirty feet in circumference; the trunk was some sixty feet long, all petrified into solid stone. This tree exhibited the roots united to the butt very plainly. It was uncovered during the summer of 1873. The next largest petrified tree measured some eight feet in diameter at the butt. These large trees are supposed to be Red wood species, the same species as the Tuolumne, or Calaveras "big trees." The petrifactions ex-

tend over a field of one hundred to two hundred acres, where small and large lay scattered plentifully about. They are mostly silicate petrifactions, and in many specimens quartz crystallizations are prominent. In the forest, extensive chemical deposits are found, which are supposed to petrify the decomposed wood by infiltration, or saturation. The question is raised among scientists whether or not the forest was petrified standing, the trees afterward falling, and gradually becoming buried in the earth; or whether the trees petrified after they fell, during the slow process of decomposition. The latter theory finds favor with the proprietor and others; but I differed with them, and incline to the opinion that the trees petrified standing, and that it originally was a standing, petrified forest. My belief is that the ground, although not a swamp, but an upland, was covered with trees, and at a later period of its history was submerged by water, and after remaining some years in this watery grave the trees began to decompose (as is well known all forests will, while a portion of their trunk and roots are continually submerged), and, as the slow process of decomposition took place, the air in the vicinity, thousands of years ago, was filled with silicates, or chemical mist, which was constantly sent forth by the hot springs with which this forest is surrounded, and

which to-day are boiling and belching forth mist in the form of steam and vapor; and, while the process of decay and decomposition was gradually passing on, the chemical mist sent forth by the hot springs or geysers, filled or saturated the tree, and as the wood decayed, the misty chemical or mineralogical properties deposited, hardened into their natural element, a mineral, and in due process of time the entire wood of the tree, as it very gradually decayed and passed off, was displaced by the misty mineral deposit, and the form of the tree, and even the grain of the wood preserved as a solid mass of stone; and thus the whole submerged forest passed through this transition state, from trees of dead wood to trees saturated with mist from the hot springs or geysers, ages past, and thence the mineral saturation hardened in time into stone. On visiting the geysers we observed the mist or vapor described deposited around the springs constantly hardening into stone, and the tree need not necessarily lie in a horizontal position to be saturated with soluble silicates to become petrified, but as heretofore explained, can with equal facility, be impregnated or saturated by the mists of the air arising from the hot mineral springs, which must in ages past in this locality been very considerable, as is known even partially to-day in the geyser region of the Yellowstone. And then as these

petrified trees lay upon the ground, the larger ones, especially, are broken transversely across the trunk in several places, and very straight, which would exactly occur providing the tree was petrified standing, and falling as a stone column, breaking in several pieces directly across as it struck the rocky ground. If the tree fell when in wood, unpetrified, this coincidence would not naturally occur, but would either have remained whole as is general with trees in the woods that fall, or else split and break in different directions; hence the deductions from my investigations are that this, in ages past, was a standing petrified forest.

Dead bodies are sometimes encrusted with lime, as found in the Mammoth Cave, where all bodies remaining fixed are soon coated with this substance constantly dripping from the roof and gradually forming, drop by drop, those beautiful stalagmites and stalactites for which this place is so famous.

CHAPTER V.

CRYSTALS.

A crystal is usually formed through the action of heat. Fill a porcelain dish with a solution of salt. Heat it moderately, evaporation will take place, and small crystals of salt will be seen forming in the dish. All crystals in nature possess certain shapes and forms characteristic of the class to which each belongs, so that a good crystallographer or a thorough mineralogist can as easily detect a crystal and give one its name by the angles each presents, as the botanist can identify a phenogamic or flowering plant by the stamens, pistils, petals and other properties peculiar to its flower. Quartz crystals are perhaps the most common. Rock crystal, amethyst, rose quartz, chalcedony, carnelian, agate, flint, jasper, and opal are included in its varieties. Among alumina crystals are garnet, tourmaline, topaz, and sapphire. The most common variety of sapphire is blue. Red is rare and valuable, and brings at times as high price as a costly diamond of equal size. This crystal exceeds all others in hardness save the diamond.

The diamond is a crystal found generally in

alluvial washings; its composition is pure carbon, and is undoubtedly of vegetable origin. When heated sufficiently intense, it will burn until nearly consumed, throwing off smoke in the form of carbonic acid gas the while. It was probably crystallized when the rock surrounding it was formed, and as the rock decomposed and fell to pieces, the diamond crystal, being much harder retained its form among the small fragments of broken rocks washed or worn into pebbles and sand. When first found it resembles glass; a novice would pass it as nothing of value, and it is only when cut into various forms and shapes, as sold at the shops, that the great brilliancy of the crystal is appreciable. After the fact became known that the composition of the diamond was identical with charcoal, it was suggested that the former, through a certain process, could be manufactured from the latter; the experiment was made, and success attained in so far that crystals were formed, but they were so small that a microscope was necessary to detect them, and the expense attending the manufacture so great (amounting to more than the crystal's value) the enterprise was abandoned, and charcoal left in its undisputed right to serve us in its own useful way.

Many other varieties of crystals might be mentioned, as they occur throughout the mineral

kingdom and constitute most of the rocks common to us, which are simply an aggregation of crystals.

Sand, carbonate of lime, silicate of soda, and a solution of chloride of calcium, mixed, cements the compound into hard and durable stone. Add quartz and oxide of iron, and artificial granite is made; use other ingredients, and marble is formed.

CHAPTER VI.

ORES.

Most of the ores or metal are so combined and disguised with other substances, that assayists are obliged to resort to analysis to detect the metal sought; sometimes a very simple test is quite sufficient, as for example, take sulphuret of copper and direct the flame of a blow-pipe upon it, a coloration to the flame is given, which with copper, is green. This metal occurs largely native or pure. In the vicinity of Lake Superior, large masses are found, weighing in some instances from three to four thousand pounds. One lump proved to be an elephant on the company's hands; it was so large it could not be removed, and so ductile it could not be split or broken; hence the mammoth treasure lays in its bed in undisturbed quietness. An alloy of copper and zinc, say one third zince and two thirds copper, makes brass; and an alloy of tin and copper makes bronze, and bell metal. Malachite, a green carbonate of copper, is manufactured into ladies' ornaments.

Zinc ore is obtained in China, Europe and the southern and middle portion of the United States.

It is never found native, but occurs as oxide and sulphate of zinc. The ore yields thirty or forty per cent. of the metal. Tin rarely occurs native, and is generally combined with sulphur and oxygen. The most extensive mines are at Cornwall in Great Britian, and in Saxony and Austria. The veins are but three or four inches thick, the gangue or rock surrounding the ore is mostly quartz. The best ores yield some sixty or seventy per cent. of the metal. Pure tin is valuable. Tin ware sold at the shops is simply sheet iron coated or washed with tin. The reduction of the ore is brought about by nearly the same process as with other ores; it is crushed and washed, and placed in a reverberatory furnace, and the metal through heat is separated from the sulphur and oxygen, the two latter, when heated, being volatile, escape into the air. Arsenic is a metallic ore; it occurs native, and also in combination with the ores of iron, silver, nickel, cobalt and lead. Being volatile, a moderate quantity is easily detected on charcoal with the aid of a blowpipe, by a white substance deposited in the form of a ring at a little distance from the assay. It is found in Bohemia, Hungary, and in the United States. The ore is crushed and put into a reverberatory furnace; when heated it vaporizes and is condensed in a tall chimney. It is then collected, and is known in the shops as white arsenic.

The men employed in working these ores are short lived, their age rarely exceeding 30 or 35 years. To give porcelain, and a white appearance to glass, arsenic is at times used in the manufacture of that article.

Silver is found native, or pure, and also in combination with arsenic, sulphur, antimony and lead. The most extensive mines are in Mexico, South America, Europe, and United States. In some mines in Colorado, a ton of the ore yields about a thousand dollars worth of silver. Gold occurs native, and is also largely combined with sulphur. It is often found in quartz, and in such minute grains that it cannot be detected by the naked eye. When it occurs in this form, known as quartz gold ore, and in another form known as sulphates, (these two constituting most of the ores at present found in California and Colorado), the process of extracting the gold is very difficult. After the ore is crushed and washed, mercury, which has a great affinity for gold, is used; an amalgam formed, the mercury attracts the gold, and the former being volatile is burnt off in a furnace, the gold remains; and, after a few other processes, the noble metal is distributed to the world.

No process has yet been discovered to separate entirely the sulphur from the gold economically; it is only partially accomplished. Chemists and

mineralogists are now at work in this direction, and when the problem is solved—and it certainly will be—gold will be more abundant, for the mines in Colorado and elsewhere are yet rich with this treasure. As it now exists there, the expense in many instances in extracting the gold is greater than the value of the metal obtained; hence the ill success in operating some mines in that region. Generally where these sulphates are seen gold is found; hence the question is discussed by some scientists whether or no sulphur does not contain the same properties as gold; and as the diamond is simply charcoal, carbon, refined or crystallized, is not gold, sulphur refined, condensed and solidified? The largest lump of native or pure gold yet discovered was found in California, weighing one hundred and thirty-four pounds and seven ounces, valued at twenty-seven or twenty-eight thousand dollars. Pure gold is about twenty-four carats fine; but in this pure state it is too soft for general use; hence in hardening it, it is mixed with copper or silver. Four parts of copper or silver, and twenty parts of gold, make the latter twenty carats fine—when eighteen carats, it contains eighteen parts of pure gold. Cinnabar, a sulphuret of mercury, is found largely in California, and being so near at hand the metal is conveniently used in the separation of gold from its combinations before described. The

great affinity of gold for this metal is illustrated by the story of the old woman who seeing some mercury in a lecture room stole some by pouring it in her gold spectacle case. On arriving home she emptied the treasure in a bottle, and put her gold spectacles in the case, when to her sorrow, the following morning, nothing but the glass of her spectacles was left. The case was so saturated with mercury, it dissolved the gold frame, and absorbed it in the leather covering.

CHAPTER VII.

ROCK ACTION.

The crust of the earth which became solid in consequence of the gradual cooling of the surface of its fiery fluid was, in its original state, one universal mass of rock; soil nowhere visible; rock here, rock there, rocks everywhere—rocks above water, rocks below. Ages passed, and they began to decompose, the adhesive properties that held their particles or crystals together, dissolved, and by constant wear, the latter were converted or powdered into dust or soil. Atmospheric and chemical agencies work marvelous changes upon the toughest solid. Wind is active in wearing away rocks. Slow is the process, "The mills of the Gods grind slow, but exceeding sure." No substance is so hard, whether rock, iron, silver, gold, or flint, but what in time must suffer loss or decomposition, when openly in contact with atmospheric currents. It is a law universal that every substance must lose in weight by friction, however slight the motion producing it. The effect however of wind currents is very slight in comparison to the erosive or wearing action of water in effecting changes upon the earth's sur-

face. Visit a mountain or some neighboring hill, and if the rocks are covered with earth and undisturbed by wind or rain, the stratification or layer will in many instances remain unbroken or continuously connected, uneven perhaps like the ocean's surface during a heavy sea or storm, but no break; while if another spot or bed of rock is found uncovered or long exposed to the wearing action of wind or rain sweeping across its surface, the top of the rock, rounded like in form to the ocean wave, is worn off, so that the stratification is broken, and a space is left between this, say the left side, and where the seam commences on the right, the stratification appearing now more or less vertical.

Make a drawing for example of a high ocean wave, from one third of the top draw a line across, rub out all above, imagine seams running down, and instead of running continuously over the crest, they break off, and begin abruptly. Thus a true idea is given of these huge rocks, rounding mountain tops, as found by geologists, worn away largely by the continual action, or beating of rain and wind against their surface; the waste constitutes soil which is simply pulverized rock. The pebble stones at the seashore show very plainly the action of water, their roundness reveals the many battles with the ocean. Observe a ledge of rock on the hill or mountain

side; a small stone lodges on a level portion, wind and rain sweep across and agitate or disturb the stone thereon, it moves to and fro in a small space, the friction in time grinds or wears a slight hollow in the rock. Other stones lodge there; storms continue to agitate them, a hole is at last worn, termed by geologists a pot hole, water flows in, it freezes, ice expands, the rocks cannot withstand the pressure; a crack is eventually made; water again runs in, freezes and expands, the rock splits, and the separated portion falls down the hill and mountain side to be again split or broken up into many fragments, the same as with other rocks or stones lying scattered about, by the expansive action of frost and ice, which is constantly in the days of winter, peeling, splitting and pulverizing these dense bodies into soil. The running streams contribute largely toward the disintegration or wearing away of rocks, and deposit the soil at the mouth and banks at the side of the river. The Falls of Niagara are gradually receding, having already cut a gorge some seven miles in length. The rock over which it now precipitates is worn at the rate of about a foot a year. The cañons of Colorado, from one to three thousand feet in depth, and two or three hundred miles long, are due to the erosive or wearing action of the Colorado River, while in one portion a gorge through solid rock, some

eight miles in length and eight hundred feet deep, is cut or worn by this river current. Visit the Alleghanies of the Appalachian system, and mark the effect of wind and rain upon this range of mountains. The peaks now constituting the range were undoubtedly originally fewer in number, but the action of storms about their summits hollowed a space; the peak divides; centuries widen the gap; their height decreases, and where simply one peak towered to the skies, now two, three or four, though smaller, fill the place, while the upper constituents originally intervening, wash down the mountain side, and now constitute the soil in the valley below. This erosive action is continual, and any acute observer can detect in these mountain ranges a gradual waste in obedience to the parent of all laws—change.

CHAPTER VIII.

GLACIERS.

Glaciers in the past have contributed largely in grinding and reducing rocks to soil. These immense masses of ice which are found to-day upon the Alps and in the cold regions, are mostly due to vast accumulations of snow. These accumulations, if not too dense, are melted by the sun's rays on the Alps at the rate of some twenty-five inches per day. Wind and moisture upon the mountain side contribute largely toward melting these snow-beds. The Névé which is preparatory to the glacial formation, consists of snow partially melted, a whitish and gray mass of granules, or small grains aggregated together. The lower portion of the Névé is again melted and frozen, and here the solid glacier begins, ice being also formed on the bottom by the pressure of the upper layers of the Névé; the weight of the latter in very thick beds being considerably like the pressure of the foot upon a bed of snow when walking in the streets, ice is similarly formed. An equal volume or amount varies considerably in weight, as the above transformations progress. A cubic yard of snow weighs about

one hundred and eighty-seven pounds, while an equal volume of ice constituting the glacier weighs nearly two thousand. The accumulations of snow on these mountain tops are enormous. At the height of eight or ten thousand feet it is continuous, and as the sun's rays strike upon these masses and warm them, they pass down and lodge perchance in some ravine or basin, and there remain until the accumulations are thousands of feet in extent, of immense but varied thickness, and here the melting and freezing process begins, and the entire mass is gradually converted into a glacier as above described. The sun's rays are constantly pouring upon this glacial sheet, and aided by wind and rain, some portions of this huge ice body melt, and little rivulets underlying the bed are formed, which finally unite into a river, and thus we have a large stream, called the glacial stream conveying the waste water away from the mammoth ice sheet. The glacier is found to possess an onward or downward movement, caused in a slight degree by the slow melting of its lower surface, by the many fissures formed upon its bed by the changes at work throughout the entire mass, and the constant tendency to descend the slope in obedience to the laws of gravitation. This movement was clearly demonstrated some years ago by a savant named Hugi, who built a small hut on the Glacier Un-

teraar, and found that in three years the hut and said glacier had passed three hundred and twenty-five feet below the fixed objects adjacent, and surrounding them. Six years later it moved two thousand three hundred and forty feet; five years more it had reached four thousand six hundred and eighty-three feet from its first starting point; hence it will be perceived that, although the glacier moves, its march is very slow, occupying some fourteen years in traveling scarcely a mile. The movement of the glacier is greater in the summer than winter. Prof. Tyndall records the progress of the glacier, Mer-de-Glace, as about thirteen inches per day in the winter, and more than twenty-four and one half inches per day in summer. The glacial sheet does not move regularly in all its parts; that is, the central portion travels more rapidly than the sides, the latter being subjected to greater friction by its edge grating along the bank with rocks projecting, and owing to its inequality of tension, the ice cracks, and hence most of the crevasses are found near the sides. Some of these are very large, extending one or two thousand feet in depth, and to a traveler are very deceptive, the gap or opening being covered with snow. It is usual with travelers in these regions to connect themselves by fastening a continuous rope to each of their bodies, keeping a proper distance apart;

hence if one steps on these false snow bridges the other travelers prevent him or her falling into the crevasse to any depth, by the rope attached to them, which holds him or her up. Some years ago two ladies and their guide were ascending Mt. Blanc, and disconnected by ropes; one of the former passing over the snow covering of one of these huge crevasses, fell in and lodged on a slight projection a few feet below. The guide cautiously descended to assist her in gaining the surface, when to the terror of the sister remaining above, he lost his foothold as he reached the lady below, and down, down they went fifteen hundred feet in the gaping, icy chasm, striking the sides and sending their heart rendering shrieks above.

Icebergs are simply fragments of glaciers that lay near the water's edge in the cold regions. One of the Arctic explorers, (Hayes, I think), being present during the breaking off of one of these bergs, describes the scene as terrific. "A sudden splash, the waves rolled high, and the traveler who neglected to make a hasty retreat from the ice-bound coast, was met by the advancing wave and swept into the watery deep." The rocks collected and frozen to this icy mass are carried along as the latter floats down its southerly current. When the berg reaches a warmer latitude it melts, and the rocks and debris remaining adhered to it are deposited.

The Banks of Newfoundland are supposed to have been formed through this agency, as well as a portion of our coast lying north of us. The glacier we found possessed an onward movement upon the earth's crust; instead of flowing as a river of liquid water, it runs as a river of solid ice down the mountain slope, contracting as it flows through a narrow ravine, and expanding like the water current, when it reaches a wider space, and as it moves onward, it gathers and carries with it the stones and debris that fall from the mountain side and lodge on its massive sheet. The stone is frozen to its icy bed, and by the onward motion, its sides perchance grate against a ledge of rock, and are ground partly into soil; the glacier or ice-sheet upturns at times in its march, and its stony contents being then at the bottom, it rubs along and is rapidly ground to powder, and when not entirely pulverized into soil, scratches remain on the rocky surface, termed stria; hence when a stone is found buried in the earth, worn, and upon which, running in parallel lines, are scratches or grooves, the geologist infers they are glacial scratches. During the removal of Fort Hill, Boston, some years ago, I found a large number of stones containing glacial scratches seventy-five or one hundred feet below the surface. This hill situated near the harbor, was one entire drift, the remains of a mammoth

glacier: New England in its primitive state was more or less covered with these moving glaciers. As the icy glacial sheet passes along it drops here and there its stony freight; hence a long line of stones is seen in its path, called moraines; and when the sheet is very thick,—hundreds or thousands of feet,—a boulder is found lodged on the summit of some high elevation, and the curious phenomenon excites the wonder of the observer to learn that the top of the thick, moving, massive sheet reached the summit of the eminence and dropped the foreign rock or boulder as the glacier passed along. Boulders are seen at all elevations, from the level of the sea to the top of the highest hill. Glaciers have, therefore, in the distant past contributed something to soil in grinding rocks in their onward march. Rocks are ground and decomposed by various agencies, and the soil resulting is, to a large extent, more generally distributed over the earth's surface through the action of large and small water streams.

The Mississippi sweeps down its mighty torrent each day many tons of soil, and sends it far beyond its mouth, forming a large delta, or plats of soil, depositing it also on the banks of the river side. Other rivers accomplish the same result, large streams carrying more earth than small. In most gravel banks are found stones crumbling

to pieces. The cement holding their particles or crystals together is dissolved, and the stones are decomposing, decaying, and known as rotten stones. A considerable quantity of soil is made by this class of stones, crumbling and pulverizing. The amount of soil scattered over the globe is very trifling as compared to the entire bulk of the earth, its depth not being measured by miles, but feet.

CHAPTER IX.

SOIL AND PLANT LIFE.

Soil, we have found, was originally pulverized rock, hence it must contain the same properties precisely as the rock from which it came. Where limestone is the predominate rock in a certain region, there lime is the prominent constituent of the soil; where sandstones abound, there the soil consists largely of sand; where slates predominate, a clayey, plastic soil, rich with alumina (the basic ingredient of loam) is found; where granite abounds, we have a gravelly, sandy soil, silica or quartz being the prominent ingredient. It makes a strong soil. How shall we detect limestone, sandstone, trap, granite, etc.? Pick up a bit of rock, scratch it with a knife, if it is soft, say one half as hard as quartz or flint, and if when crushed and powdered, a drop or two of chlohydric acid be applied to it, and it effervesces, it is pretty sure to be limestone, a carbonate of lime; the carbonic acid gas escaping is the cause of the effervescence when said acid is applied. Sulphate of lime or gypsum will not effervesce. Scratching the stone with a knife, detecting its softness, will answer for a general test. If a bit

of sandstone is picked up, by passing the hand over it, a roughness and gritty feel will be detected. The stone is made up of particles of fine sand, a sedimentary deposit, hardened and cemented together. With a knife it scratches about twice as hard as limestone, and equally hard as flint. Trap rock is generally of a dark green color, and is a hard, tough rock, in structure, something the appearance of the slates or sandstone, not as gritty as sandstone or as smooth or fine as slate, a mean between the two. Basalt is very similar, except its color is from gray to black, it is very tough, and is used to macadamize roads. Slates possess a very fine texture, and are so general they need no description. Granite is distinguished by its crystalline structure; its quartz by the transparent or whitish crystals, its feldspar by the opaque, reddish crystals, its mica by thin lamina or layers, with a glassy, and sometimes golden lustre, and the hornblend of our syenites (known as Quincy granite and other darkish blue granite rocks elsewhere) by its long, black crystals. The soil in its primitive state must have contained the following chemical ingredients, which the rocks in their compact state possessed. In granite regions, for instance, about three quarters of the soil was silica, or silicious sand, one eighth alumina, (mostly clay), one sixteenth postash, and a very small quantity

of sesquioxide of iron; if hornblend is present, (as in syenite), magnesia, lime and protoxide of iron are added to the soil. In limestone regions, as in New York state, the soil was composed largely of lime, say from thirty to fifty per cent., a considerable amount of sulphuric and carbonic acids, and in some localities, silicious sand. In trap rock and basalt regions, rocks resulting from volcanic and like eruptions, the soil contains potash, lime, magnesia and protoxide of iron. In slate regions we have in the soil a large proportion of clay, and a small amount of silicious sand and potash. Such were the constituents of the soil originally in these regions, but through the action of water or streams, a portion of these soils has been transported from place to place; hence to the original constituents of the soil are added foreign ingredients transported, and organic matter, humus, decomposed vegetation, etc., (the accumulation of centuries); the original ingredients of the native or predominant rock, however, are even to-day the most prominent constituents, of the soil. Turn back a moment to that period when the making of soil was in progress; when the surface of our planet was as barren as Sahara; when no oasis of New England orchards, the grasses of the great West, or the Paradise of Eden existed to break the monotonous spell of the

desolated mass of the earth's crust: not even lichens grew, or mosses, to mark the long, undisturbed condition of scattered rocks; everything was naked, and not the faintest trace of verdure seen. The question is often advanced, as one of the unexplained hidden mysteries of providence: "Explain what makes, or how the blade of grass grows?" He or she who lacks the spirit or courage to open the book of Nature is at a loss to answer, but the laws and principles of its development are explained as easily as the law of growth of any other form of matter.

Let us follow the development of a plant. A plant is simply soil in its most refined state, combined with gases in the atmosphere in by far the largest proportion. When the soil became sufficiently pulverized, saturated with moisture, and the gaseous elements washed into it by the descending rain, the ingredients buried there, assisted by the remaining gases in the atmosphere, produced a germ; produced by the extraction of the juices or the quintessence of the soil and gases surrounding—a crystallization process, as it were, like the diamond, by some chemical change crystallized from a coarse carbonic substance—possibly charcoal—into the most condensed, refined and precious of all substances. The germ lies dormant in the ground until disturbed by some atmospheric or gaseous element

without; that element, in connection with the sun's rays, is oxygen. Oxygen is the most destructive, and at the same time, the greatest life-quickening element that exists. Without it, the seed could never germinate. Let us examine the development or quickening of this germ; and when we learn the laws that govern it, we learn the process by which all seeds thrown broadcast upon our lands, or buried in the garden, germinate, develop and ripen into fruit. Every seed contains the form and properties of a full grown plant, root, stem, bud, leaves and all—but in the most compact, compressed and miniature form; invisible, most of them, to the naked eye; yet, in a dried bean, by separating it in halves where it naturally divides, the little miniature leaves unfolded with stem and root, can easily be observed by the unaided eye. When oxygen reaches the germ within the seed lying upon or within the moist earth, (moisture and a sufficiently elevated temperature being equally necessary), it is agitated, it begins to quicken, and the miniature plant within unfolds and expands. We will take, for example, a maize, (Indian corn), embryo or germ—its form something like that of a heart, with its smaller end pointing upwards. Moisten this a few hours, and within the kernel will be seen a little shoot ascending—called the plumule—from which the stem, leaves and flow-

ers develop. Within the lower portion of the germ will be found a descending shoot, called the radicale, or rootlet, from which the roots proceed. The direction of these two opposite shoots is constant or preserved in whatever position they are placed; that is, should the germ lie on its side, or even with its plumule pointing downward and its rootlet upward, the former, or ascending shoot will right itself and curve upward in its growth, while the rootlet will curve about and point downward. Even the sun's rays striking the rootlet will not cause it to turn upward, notwithstanding the popular notion that the shoot ascends simply in search of sunlight. The kernel or embryo immediately surrounding the plumule and the radicale or rootlet, is called the cotyledon; and the bulky matter covering the whole is styled the endorsperm, which serves to protect the embryo when deposited in the ground, and also to furnish it with food from its own bulk until it is developed sufficiently to depend on itself; at which period the said endorsperm is pressed aside and decays, or is absorbed by the rootlet and plumule. Take a common dry bean, plant it, or soak it in warm water, and in a few hours their development will be observed. At the expiration of one day, open the seed, and the rootlet and plumule will be found to have expanded, and each in the opposite direction. About

a day longer observe another bean in the water or earth, and said rootlet and plumule will be seen expanding still further, and merging out at either end. Another day, dig up bean number three, the extension and expansion of the germ is continued; and by continuing this process of observation day after day, one can arrive at a very good conception of the growth of vegetation, from the development of the germ to the full-grown, mature plant. The development of the seed, or plant growth, is simply the extension and increase of cells. These cells are minute globular bags, and multiply very rapidly in the upward shoot, or trunk and branches, and also in the downward shoot or root. Through the microscope one can readily view the structure of these cells, and the circulation of sap passing through some of them. The cells harden into cellulose or wood as they multiply or new ones are formed. The rapid increase of cells is perhaps nowhere better illustrated than upon the Alps, in what is called red snow. This was not supposed to be of vegetable origin until recently, when, through the analytic power of the microscope, minute vegetable cells were discovered, and it was classed among the cryptogamic, or flowerless plants. The microscope reveals that these plants are made up of flat globules, with a disk, and within filled with minute cells, which, when sufficiently

developed, protude from the parent-plant, and new disks are formed, continually multiplying, so that in the space of a few hours these little cells spread over the surface of immense glaciers, extending many miles. The vegetation that first appeared upon the earth's surface was probably microscopic, a pinch of the same lodged on the end of the finger would comprise a million plants. This microscopic vegetation exists to-day, covering and coloring some of our rocks, and the botanist is able to detect the species to which each plant belongs. During the early existence of vegetation animals appeared upon our planet, their stature corresponding undoubtedly to the microscopic figure of the plant, and upon which these little creatures subsisted to sustain life. Vegetation in all its forms and varieties is supplied with food through the roots, not at the extreme end or tip, but at a little distance therefrom, through what is called root-hairs—roots which are so small the eye is unable to detect them on most plants, but upon the roots of wheat, turnips, parsnips, carrots, and a few other plants they are readily observed, with the earth clinging to them, without the aid of the microscope. These root-hairs follow the new growth of rootlets, and as rapidly as the older portion of the root is formed the root-hairs become useless to that portion, decay, and drop off, develop upon the new, and sup-

ply the entire plant, the giant oak, as well as the mustard, with all the food that enables it to grow. They are, in fact, the great absorbants, and when the plant is removed, care should be taken to allow the soil adhering to them to remain, that these little fibres may not be pulled off, or in any manner injured. The food for the plant must be in solution, or in a liquid state, before it can be absorbed by the roots. The mineral solids about them are pulverized through the action of water or some chemical agency, and dissolved or rendered soluble, the root-hairs absorb them, and upward they flow through the vascular ducts or cells of the plant, and add new cells or growth. The leaves also perform the office of supplying some nourishment, but the amount is very small. In a dry season, when the rain falls upon the wilted leaves, they do not absorb it, as does a dry sponge. The foliage exhales moisture, and inhales but little; the rain falling thereon checks exhalation, and the plant ceases wilting, and as the water falls and percolates through the soil, reaching the roots, the latter absorb it, and send it upward to the foliage, and the exhalation continues. The morning dew performs the same office, the moistened atmosphere surrounding the leaves of the plant acts as a wet sheet thrown over them, it checks further exhalation of moisture—the wilting ceases, and the plant revives; but

when the sun rises, and the dew evaporates, the foliage becomes warm and dry, the damp, cold sheet is removed, the wilting then continues until the roots in the soil are supplied with water—wilting being due to the leaves exhaling moisture more rapidly than the roots can inhale or absorb it. Maize, during a hot summer, will exhale thirty-six times its weight of water. A large sized sunflower, or cabbage, will exhale three pounds of water in a single day; a square foot of pasture grass, five and a half pounds. To this constant evaporation or exhalation the circulation of a liquid through the plant is, in a measure due.

It is a common saying that "water will not run up hill," but the plant furnishes us with sufficient proof to the contrary. Fill a glass with water, place therein a very small, narrow, open tube; the water within the tube will at once rise considerably above the level of the liquid in the tumbler. This is called capillary attraction. The cause of this phenomenon is due to the nearness of the inner opposite sides of a tube with a very small passage, which serves, to a slight extent, as a magnet to attract or draw upward to itself any liquid matter therein contained. This phenomenon is also witnessed in the common sponge, which is very porous, or filled with numberless narrow ducts or tubes, and consequently, as in

the above tube described, possesses the power of drawing into it and retaining, by said capillary attraction, a large amount of water. The plant also, by the aid of the microscope, exhibits the same power of drawing upward its liquid food, for within it are cells or vascular bundles, which are long and slender ducts or tubes, with very narrow and minute passages through them, and furnishes a fine chance for the operation of capillarly attraction. The nutriment (a liquid) taken in at the roots ascends through the plant in the manner described, and its accumulation makes the new growth. The small amount of nutriment absorbed through the foliage passes downward through the plant. The flow of this sap in the temperate zone is not continual, for when the cold season approaches, its movement ceases. In early spring the maple tree is tapped. It discharges sap; but this movement is not the natural flow of sap from the roots, but the discharge is due to the great pressure of water contained in the tissue. At no season of the year does the tree contain as much water as in the cold winter season, and the cut or wound in the tree gives vent to the great store of water pent up within. The wood cells contain air and water; and as both expand by heat, when the sun in the spring time sends its heated rays upon the trunk of the maple, the water and air expands; and when an

incision is made, the water or sap flows copiously from the wound; the rapidity of the flow is governed by the temperature. If the weather is cold, the water runs slowly; if warm, it runs rapidly from the tree. While this flow is in operation, there is scarcely any movement in the center or sound part of the trunk. The flow proceeds within, near the bark. But when the buds which were formed the summer previous (being filled with sap all winter) swell or expand, (as the sun's heat in the spring is more strongly felt), and finally burst forth into leaves and blossoms, then the natural flow of the sap has begun, and not till then; while the water sap near the outer portion of the tree ceases flowing through the incision made, and the wound heals over. All deciduous trees, or trees the leaves of which drop off in autumn, possess the same flow of sap. The composition of sap is mostly water. In winter as it collects, the starch contained in the wood or cells is converted into sugar, which latter, soaked in the water about it, gives us in the spring time from the maple the sweet rich sap, which all deciduous trees possess to a greater or less extent. Evergreens contain no starch of any account, hence sugar in them is not formed, and accordingly the sap is not sweet. Although all plants absorb but little nutriment through its leaves or foliage from the atmosphere, yet ninety to ninety-

nine per cent. of its food is derived indirectly, and but little directly from the latter source. Nitrogen, one of the constituents of the air, is washed down from the latter by heavy rains, forming nitrates. Oxygen, another prominent constituent of the air, comes in contact with minerals, and oxidizes them; all of which are incorporated in the soil, and the plants through their roots absorb and feed upon them. Between the plant and the animal, there exists a wonderful economic relation. Man inhales oxygen, and exhales carbonic acid gas. The latter is poisonous, and if some provision was not made to carry off or absorb it, the existence of animal life upon this globe would be impossible. It is estimated that man alone exhales into the air sufficient carbonic acid gas to produce one hundred and twenty-five billions four hundred million tons of carbon in a single day, saying nothing of the incalculable amount exhaled by all animals, and the amount expended by the combustion of wood, oils, coal, etc., as well as from the ripening and decay of fruit, germination of seed, putrefaction of organic substances, etc., etc. A candle will not burn in air containing three per cent. of this poisonous compound; thirty per cent. will kill a man quickly, and six per cent. only will make it so uncomfortable for him, death will ultimately ensue if he fails to effect his escape. Nature, how-

ever, is equal to the emergency, and provides in her economy a fair exchange—what is poison to us to inhale, is food for the plant. Absorbing the carbon, it exhales also oxygen, and we inhale it; thus a complete reciprocal relation is continual between the animal and vegetable kingdom. What is waste for one, is food to the other.

CHAPTER X.

OCEAN.

The ocean occupies a much larger portion of the earth's surface than the land, and is very much deeper than the average height of the latter; the average depth of the ocean being some fifteen thousand feet, while the average elevation of land above the sea is but one thousand feet. Could one stand at the bottom of the deep and look about and above him, Nature would be seen in all its variety and grandeur. Around us, upon the ocean's bed, lay shells and shell animals of all descriptions; above, fishes without number; beyond, a deep valley, where the ocean's depth measures some fifty thousand feet; further on, a hill, a mountain, in the deep, towering above our heads. Descend the deep valley, and instead of finding the bed devoid of plants, we discover trees prodigious in size, their limbs are like trunks of trees, not tapering at the ends as the branches of land plants; they are adorned with beautiful colors, and as we stand upon the bed of this ocean valley, our eyes are directed upward, and lo! not only do we observe the mountain of the deep, which may extend some forty thousand

feet; but, elevated above the surface of the sea, upon land, there are mountain peaks reaching some twenty-eight thousand feet, and as this is one continuous elevation (with possibly a more graduated plane between) from our ocean valley, the mountain top towers some seventy or eighty thousand feet. This scene presents to the dweller of the sea, (would its power of vision allow), nature in its most resplendent grandeur. It would appear that the surface of the earth above the sea level is very uneven, and yet the highest mountain is but a slight elevation compared to the earth's entire surface. Stretch a line upon the wall of a hall forty feet long, paste upon the straight line drawn a bit of paper a quarter of an inch in height, and the latter is to forty feet as the highest peak is to the earth's entire surface, which is, in reality, scarcely discernable.

CHAPTER XI.

WATER.

Water is composed of two elements, hydrogen and oxygen, eight ninths oxygen to one ninth hydrogen. Separately, they exist as gas; and it is incomprehensible to some, that existing in the air in their separate capacity as a gas, what manner of proceeding are these gases converted into a substance as visible, tangible and ponderable as water. The moment these two gases come in contact with each other in proportion as mentioned, a chemical union takes place, a condensation of the gases and water is the result. Most gases may be condensed into fluids, and nearly all fluids condensed into solids. Liberate the heat, and contraction, condensation, is the necessary result. Water is decomposed or converted into its gaseous elements by the aid of electricity. Rain is due to the condensation of vapor in the atmosphere. Take a glass retort, fill it partially with water, place the nose of it in a glass receiver, rest the latter on a cold water bath, and heat the retort over a spirit lamp until vapor rises from the heated water, the vapor then passes through the nose into the receiver, the air

of which is made cold by the vessel resting on cold water; and the vapor coming in contact with the cold air condenses into globules or drops of water. This is the process of distillation. The sailors at sea when out of fresh water, are in the habit of filling their kettles with salt water, heating it over the stove and cooling the escaping vapor; condensation results, and drops of fresh water lodge in their pails. Heat separates the salt from the liquid, and nothing but aqueous vapor escapes. Machines now fill their wants in an easier and more rapid manner. Apply the huge lamp, our sun, to the great vessel, the earth, three quarters covered with water, and we have distillation on a liberal scale. The rays of the solar mass strike the ocean or any sheet of water and heat the surface; heat expands, and water with which it comes in contact is expanded, enlarging and growing thinner as the heat spent upon its surface continues, so that at last, it is expanded into vapor, and becoming lighter than the air through this expansion, it is obliged to rise, and will continue to rise until it reaches that elevation where the atmosphere is as light as the vapor, and there it rests, or floats here and there until a cold current strikes it; and as it is the law of all substances coming in contact with colder to contract into smaller space, so the vapor meeting the cold current contracts, or condenses into

drops, becomes heavier than the air, and obeying the laws of gravitation falls to the ground in the form of rain. In hot climates, at the tropics, double the quantity of rain falls than in the temperate or colder regions, which is due to the increased heat evaporating larger quantities of vapor, and notwithstanding the excess in the amount of rain in the tropics, the showers in the temperate zone, though less severe, are more frequent and evenly distributed.

Snow is formed by vapor rising to greater heights in the atmosphere—consequently cooler—and is frozen in the form of vapor, congealed, not condensed into drops, as rain. Go to the mountain side, ascend seven or eight thousand feet, and you come to what is called the snow line. On the Wasatch Range in Utah, and the Sierras, I have seen in May this line distinctly marked. Below, the verdure is made manifest by frequent visits of rain; above you are in the region of snow. Ascend higher and you reach perpetual snow. Continue to ascend, and ultimately the limit of snow is passed, now and then a flake is seen, but no accumulation. Water in the atmosphere surrounding our planet extends about six miles in height, above that elevation the air is dry.

Hail is frozen rain. Snow forms in the atmosphere in summer as in winter; but the radiant

heat of the earth in the former season melts the snow crystals ere they reach the ground. With hail, the frozen drops are of such size, heat does not as easily effect them. Fill a glass with ice water, let it remain in a hot room, and shortly vapor is seen to collect on the outer portion; it is further condensed into small globules of water. This is called the dew point. The cause of this phenomenon is due to the ice water cooling the glass, and when the warm air without, which contains mositure, comes in contact with the cold surface of the glass, said moisture condenses as before described.

The earth during the day receives the sun's rays, and its heat is constantly radiated back into space. At night, however, when the sun's rays have ceased shining upon that portion of the globe we inhabit, the earth receives no heat to compensate for that which it radiates into space, and consequently the greater part of its surface heat being expended, the ground becomes cold, and the air retaining its heat longer than the earth, its moisture coming in contact with the cold surface of the latter, is condensed into small globules or drops; this is dew and all vegetable life is blessed with this refreshing phenomenon. Dark surfaces radiate or expend more heat than light; consequently being cooler they condense more moisture, and heavier dew is found thereon.

Frost is simply frozen dew. Fill a test tube with water, drop in a little saw dust, heat it, and you will discover that the heated portion, expanding and becoming lighter, rises and passes along the upper part of the tube, while cooler, being heavier and more dense, flows upon the bottom; it is heated again, rises, cools at the top, falls again, and thus in water, circulation is found perfected.

In the ocean this circulation is detected in the Gulf stream, and the flow of the cold Arctic current. The heated waters of the tropics, having become expanded, flow along the upper surface northerly, or more properly northeasterly, while the Arctic stream flows southeasterly; being colder, and consequently more dense, flows deeper and under the Gulf stream, and onward toward the equator, where it becomes heated, rises and passes with the warm current towards the north again. These currents are easily detected by the mariner as they flow like rivers through the ocean mass. These streams would run directly from the south to north, and north to south, if not affected by the earth's rotation on its axis from west to east, causing the Gulf stream, commencing near the equator, to partake partly of the same motion, and hence its northeasterly course, flowing across the Atlantic in the direction of the western shores of Europe. It is heated air rising from the Gulf stream current

that gives those western slopes their mild and even climate; the temperature of England, notwithstanding its latitude is 53½ degrees north, or thereabouts, while that of Massachusetts only 42½ degrees, is warmer than the latter. In the Pacific flowing from the equator, northeasterly, is the Japan stream, corresponding to the Gulf stream in the Atlantic, touching the western shores of North America, and giving to California a warm, mild climate. C. H. Dall, the geologist, who has made a careful geological survey of that region, informed me that at Sitka, 62 degrees north latitude, some 20 degrees further north than Boston, the climate is actually warmer at times than in the latter city. The Arctic current coursing southwesterly, is also changed in its direction from north to south by the earth's rotation, and instead of following the motion of the latter from west to east, it flows opposite, the cause of which is due to the very slow motion or revolution of that portion of the earth about the North Pole, the same as the slowness of motion of the hub of a wheel as compared to the rim; taking the equator of our planet for the rim, or its greatest diameter, objects thereon are carried with much greater rapidity; hence the Arctic stream not partaking of the same motion as the earth, courses partially opposite, its mass at the pole never receiving the full proportion of the sun

or moon's attraction, and like the water in the bucket, when left to itself does not receive the motion of the body in revolution containing it. Thence this cold Arctic current flowing from northeast to southwest, strikes the shores of Maine, Massachusetts and other states, giving us a cold, chilly, disagreeable climate, which the western slopes of the continent so fortunately escape. Water will not condense below 40 degrees Fahrenheit. Any temperature above or below this point will cause the liquid to expand. Increase the temperature 8 degrees, making 48 degrees, and lower it from 40 degrees minus 8 degrees, making 32 degrees; the expansion at the lowest point is just as great as at 48 degrees. It is this law in connection with the circulation and non-conducting power of water that prevents our lakes, the ocean and all large bodies of water being frozen from top to bottom. Nowhere is the economy of Nature more wonderfully displayed than here; if not for these laws, the lake, the ocean, and all bodies of water would become one solid mass of ice. Our summers would not be long enough to thaw it, fishes and all marine life would perish; man and beast, though they survived this contest, would be exceedingly troubled. When the cold air of winter strikes across a sheet of water, it extracts from the surface its heat; the cooled portion contracts, con-

denses, falls to the bottom, the warm portion rises, is cooled or robbed of its heat by the passing cold breeze, condenses and falls, and in this way the circulation continues. In very shallow bodies of water the entire mass loses its heat sooner than in greater depths. It freezes at a temperature of 32 degrees F. in fresh water, and about 27 degrees in salt. Ice can thus only be formed where the entire mass of water (ponds, lakes, etc.) reaches the temperature of 40 degrees. In deep water, such as the ocean and deep lakes, this density cannot be attained, because there are such great depths of water to fall and rise from which the heat is to be extracted by the passing cold air; summer arrives before the entire mass can attain said density, and consequently cannot freeze except in the Arctics where continual low temperature prevails. When a body of water reaches the density of 40 degrees it expands, and consequently floats on the surface, and when it attains the temperature of 32 degrees it freezes, expands, and floats.

A spring is simply the result of water seeking its level. Hills are varied in their composition, some gravelly, sandy and porous, through which the rains can percolate to a considerable depth, while others contain but a very thin layer of gravel or sand, below which rests a thick strata of clay, impervious to water, and consequently

being unable to penetrate this hard pan, the water runs off until it reaches a favorable outlet through which it bubbles up in the form of a spring. This outlet may be in the valley, or on the hill or mountain side a thousand feet high. Springs on the mountain top in ages past were worshipped by the ancients as something supernatural, but science in this, as in most mysteries, has through its searching investigations unveiled it, so that for all phenomena a cause is found, with nature and its laws for its common parent. Beneath our feet, underground streams and rivers are constantly running; here a little rivulet, and beyond a river fed by streams which swell the current as it dashes along thousands of feet below the surface; when one bores into these inner regions and reaches this river current, (the source of which is some distant hill or mountain), water, seeking its level, gushes up through it fountain-like, and thus a perpetual stream or artesian well is made to serve us to great advantage here upon the surface. There are Thermal or hot springs as well as cold; the former are due to the great depth of the subterranean stream, running over heated rocks and forced up by the vapors and steam formed, as with the celebrated geysers in Iceland, which throw up at times heated water two hundred feet above the surface; also sufficient steam escapes to cook the food for the traveler who

turns to account nature's ground streams. When it runs over a bed of sulphur or sulphate of iron, the liquid becomes partially impregnated with these minerals, and thus we have at Saratoga and other places of resort, sulphur and iron springs; if a magnesia spring, the stream has passed over a bed of magnesium salts and becomes impregnated with magnesia; if a salt spring, as in Syracuse and Prussia, the water has passed over a ledge of common salt, (chloride of sodium), and becomes saturated with this mineral. In Halle, Prussia, ten thousand tons are obtained yearly.

Water expands some 1,700 times before it is converted into steam. Steam is invisible, the white clouds escaping from the tea kettle or steam pipe is vapor, not steam. In boiling water, bubbles forming at the bottom are caused by heat expanding the water, and as they rise, (the surface being cooler), the bubbles condense, collapse and burst, the air escapes and singing results. When the kettle of water becomes heated to 212 degrees, the bubbles cease condensing, rise to the top, and form a thin film over the water, remains quiet a moment, sinks a little and breaks, this is boiling.

CHAPTER XII.

EARTHQUAKES.

There are two or three hypotheses in relation to the condition of the interior of the earth. One is the theory that the earth in its early history was a hot fluid mass from the outer to the centre of the earth's mass, and began to cool as most substances do from the outer towards the interior, and the other hypothesis, advocated by Dr. T. Sterry Hunt, is that the earth's liquid mass began to cool from center, solidifying from the centre toward the surface, until the entire mass of the earth became one solid rock. This was practically illustrated by him in experiments with bismuth, lead and other metals, which converted by heat into a liquid mass, commence to cool, solidify at the centre, and continue to solidify from the centre to the surface. This experiment we have tried with the same result. Water he claims is about the only substance that will cool and solidify at the surface first. [For further elucidation of this hypothesis, I refer to my work on the "Birth: Development and Death of our Planet—or Breaking Up." Page 82, Second Part.] There is considerable show of plausibil-

ity in this theory advocated by Dr. Hunt and others, but for the purposes of explaining the phenomena of earthquakes, neither theory will conflict with the elucidation of the subject before us.

Humboldt advances the theory that below twenty-two miles of the earth's crust, everything, (rocks, metals, and all), is a molten, liquid, seething mass, that the crust we are walking upon is as thin in comparison as the crust or shell of an egg is to a fly walking upon it. This is substantiated by the fact that for every sixty feet descent into the earth, the temperature increases 1 degree Farenheit, and in this ratio for twenty-two miles the heat will have increased sufficiently to melt the hardest of the earth's substances. We can certify to the truth of this assertion by experience in descending into many mines in California and Nevada. In the mine at Nevada, on the celebrated Comstock lode, at the depth of one thousand and five hundred feet, it was so hot the perspiration run from my face as water will run from a duck's back. In one recess at this depth it was so hot an egg is boiled in the water in fifteen minutes. It is dangerous to life. The miners could work in these recesses but about eight minutes at a time, and then escape to the channel or street where a draft of cooler air was had between two shafts—a half a mile or a

mile apart—that led to the outer world, the hot air escaping up one shaft, and the cool air passing down the other. The same heat, in proportion to the descent, we experienced in passing down many mines in California. It must now appear to the minds of the reader, that the earth's crust is not as stable as it might at first seem, for at some distance before this crust reaches the fiery, molten, liquid mass, it must be more or less plastic, and still farther up there must be a certain softness existing in the rocky bed. We are now prepared to estimate upon the partial unstable foundation of the crust upon which we are moving to and fro. This being the case we can begir to understand why we should hear and feel an occasional racket from the depths below. Another phase of the case will explain still farther the movements of the rocky crust. While the interior of the earth is continually expending its heat through the belching of volcanoes of its hot, molten lava and solid flame, the earth is contracting, growing smaller, and its solid crust wrinkles and shrinks, the same as the skin of an apple after the process of baking, the juices dry off and escapes, and the skin wrinkles, presenting here a hollow, a valley, and here an elevation, which upon the earth is a hill or mountain. Ascend one of these mountains and examine its formation with the eye of a student, and you will

find after careful investigation, that the rocks are folded one over the other, and at an angle of 45 degrees more or less, continuing over the summit, down on the other side, folded over in a half circle at the top and unbroken, if it had not been for the wearing action of rain, snow, winds, etc., beating against it; but this continual action for centuries, thousands of years, aye, many millions, has presented to our view a broken, folded top, worn away, cut off, so now what you see is a partial, perpendicular folded rock, abruptly terminating, with the top, rounded fold gone. In these shrinking, folding movements of the earth's crust, there must not only necessarily be changes of position in the rocks, but fractures, cracks, and rents must occasionally occur in them during these processes, a result sooner or later of these developments. When the latter disturbances do occur, the outer surface of that portion of the crust, where the disturbances exist, must feel it, and the inhabitants of that locality must not only hear but feel the shock. Sometimes where cracks or fissures already exist, a dropping of the divided portion of the rock takes place in the interior, and then the other divided portion will pass horizontally over it; when this takes place a heavy shock will result, buildings will topple over, and possibly lives be destroyed. Sometimes the severed rocks lying underneath will in move-

ments up or down grind against the other, and the rumbling, trembling noise heard and felt above is due to this underground action. Again the movements of the rocks underlying the surface through the force of steam, are pushing, pressing, and crowding each other, and possibly nearly all the time there are slight movements in these deep rocks, so slight in its effects that they are not easily felt by the inhabitants above, and can only be discovered by the scientist, or rather the scientific observer, who by some delicate instrument is able to detect these frequent oscillations of the earth's crust, and determine to what extent, both as to the area of surface, and intensity of disturbance the phenomena exist. There are some portions of the earth that rarely, if ever, feel the effects of this dreaded convulsion. The northern part of North America is rarely ever visited by earthquakes. It does not happen to be in the locality of internal disturbances. It will be found upon investigation that earthquakes more frequently visit the slopes of continents bordering the ocean, and to some extent parts of which lie in a region more or less distant from the shores of deep seas, and a few extensive river courses, as for example, on the Pacific slopes of North and South America, and perhaps less frequently on the Atlantic slope of these same continents, also on the con-

tinental slopes to the ocean in the eastern hemisphere. And again we find them occurring on slopes bordering on the Mediterranean Sea, and in the central portion of the great water basin of the Mississippi Valley. It would appear that the disturbances of the rocky crust are largely confined to the slopes of these great water basins, and it is possible that the slopes to these deep waters being more largely covered with sedimentary deposits in the form of rocks and soil, that a larger amount of heat is generated below the surface than farther in the interior of the continents, and the extra heat generated causes greater disturbances, rents, and movements in the rocks below.

CHAPTER XIII.

VOLCANOES.

It will be found upon examination that volcanoes are more confined to the shores of deep waters, or near them, than earthquakes mentioned in the preceding chapter, and, generally speaking, not only deep waters, but the deepest waters. Earthquakes were not limited to the deepest waters alone, as we see they occurred to some extent near the coast of the Atlantic, and in a region not very far from the Mississippi, while volcanoes rarely ever have occurred, if ever, in these regions. But they are found near the coast of the deep waters of the Pacific, as in South America, Central America, and Mexico. Volcanic action may be due to the great disturbances of what is popularly termed, the fiery, liquid, molten mass in the earth's interior, twenty miles and more below. The seething, boiling, and moving mass, bubbling and spouting in a mad effort to find vent somewhere, in escaping from its imprisoned walls, it is not surprising that when an opening through the crust is reached, said opening being made by the cracking rocks in their uplifting, elevating, and folding movements, described in the previous

chapter, it is not surprising, I repeat, that this pent up liquid, fiery mass forces its way up and out these rents into the open sky above. Evidences of this movement we see in the formation of the dikes that we see distributed in rocks in various parts of the country. There cannot be much question that ages ago a rent, an opening caused by some internal movement, was made in the rock, and the molten, fiery plastic mass was forced up from below to fill the opening, and in the process of time hardened into solid trap rock. Another hypothesis advanced is more recent, and perhaps more popular. A great amount of matter, in one form or another, is washed down to the bed of the ocean by the aid of rivers and other streams pouring into its mass. Not only this, but countless, aye, myriads of shells, both large and small, are incessantly being deposited upon its bed. There is a small, almost microscopic shelled animal, two or three species, that drop their shell and cover alone the ocean's bed.

These deposits of shells, with river and stream earth deposits, in the course of thousands of years, accumulate to a considerable depth, and harden into rock. This is called sedimentary rock. In the hardening process the water it contains does not all get out, but remains in, and in more or less quantities underlying each layer. In the course of thousands of years these rocks

obey the laws of gravitation and press down more and more. In the course of thousands of years other accumulations harden into sedimentary rock, and as the accumulations or rocks thicken, the mass underlying these sedimentary rocks below, and the rocks themselves at any considerable depth, become heated by the immense thickness of deposit resting and pressing above them, so hot at a few thousand feet deep that the water scattered through the rocks and below them is converted into steam; and it does not draw largely upon one's imagination to realize what a great force is at work when steam and its attendant gases are pent up at these depths below; hence when the movement of the subterranean rocks occur, (already described in the previous chapter upon earthquakes), rents, cracks and openings are made, this mighty pent-up force finds its way to this opening or openings, and up it shoots carrying everything along its path with it, whether rocks, molten matter—we call lava, or other material converted into scoria and ashes by being burnt on its passage up and out. This eruption will cover in some instances miles and miles of surface in extent around the burning volcanoe, as has been discovered at Pompeii and Herculaneum. The vast accumulations of sediments and sedimentary rocks upon the ocean's bed already described, is of such great weight as

to cause not only the bed of the ocean to subside, but the shores and coast bordering upon it. This is observed upon the coast of New Jersey, Maine, and other places upon the Atlantic. But the constant successful effort of nature at these depths to raise and elevate the mass above it is so great, that not only is the bed of the ocean preserved from a too great subsidence, but the continents through this same uplifting force is saved from washing and wasting away into the ocean; but for this economic and equalizing element in nature, in the course of ages, the continents and islands would be leveled to the sea. And again, this economy and exchange in nature is revealed to us when we are aware of the great amount of good, instead of apparent evil, the volcano is to us. It sends up from the inner depths an endless amount of chemical material to renourish and replenish the earth, and a large amount of matter is being dropped out of sight every day in one way or another into the bowels of the earth. There is more going on below the surface of the earth than one can dream. One can hardly realize the extent of surface which some volcanic eruptions have covered; they seem to establish an equilibrium between the outer and inner world. The eruption of volcanoes will ever continue while the earth contains an excess of heat in its depths; when this becomes expended into the outer air,

as it is doing continually, then, and not till then, will volcanoes become extinct, and it will be a sorry day for the inhabitants of the globe, if any, when this takes place; for it will be a cold epoch for a hot blooded animal in that era.

CHAPTER XIV.

FORCES.

Forces are correlated to each other; a mutual or reciprocal relation exists between them. Heat and motion for instance are forces; heat is entirely dependent upon motion, and motion equally dependent on heat; heat is motion and motion heat, one cannot exist without the other. Light is motion, and it is only through the assistance of the latter that we are enabled to distinguish the former; the same is true of sound and electricity. Pick up a bit of iron, strike it on a board, sound is produced, and the tingling sensation the hand experiences acquaints us with the vibratory motion, or vibrations of the rod which produce the sound. If motion met with no resistance, heat could not be detected, there would be no heat, but as all manner of motion upon our planet is attended with resistance, heat, perceptible, or imperceptible, is the necessary result. Toss a ball into the air, and were it not for the resistance of the latter, and the gravitation to the earth's centre, it would continue to roll through the vast realms of space. Motion is an immense force. The universe is at its bidding, and when apparently in

a state of rest, decomposition is silently taking place. An animal dies, the body is not at rest, but chemical action takes place until dust fills the space, and then unsatisfied, it seeks some form of life again; a plant grows over the spot, it absorbs a portion of the remains, the plant in turn is eaten by man or beast, and thus it passes through the life route again; hence motion is constantly discovered in everything, in the formation and decomposition of rocks, and in nature everywhere. Change, in the form of motion, is the universal law; carry a stone to the mountain top, and the distance from the centre of the earth being increased; the rotation of our planet on its axis is effected, though imperceptibly so, and this small deviation cannot occur without the entire universe feeling its influence, however infinitesimal the extent. The motion in raising the arm disturbs the equilibrium of the atmosphere to the remotest corner of a room. This is exemplified somewhat by tossing a pebble into the ocean; observe the large extent of surface of water ruffled or agitated by the falling of that tiny pebble.

When the arm is elevated and falls at our side, it would appear that motion is destroyed, or ceases to exist; this however is not true. When the arm is raised or lowered, the air is pressed back, for the arm and the former, or any other two separate substances cannot occupy the same space at the

same time. As the incumbent air is pressed back by the motion of the hand, other portions must give room to the first, which is also in turn pressed back; the latter pushing other portions of air still further on, in all directions, and thus not only is the motion, or the first impulse, felt throughout the atmosphere; but if space is filled with ether, the pressure continues, and the motion or impulse passes through all space, reaching in fact the most distant star, however slight and imperceptible the effect.

Heat is the correlative of motion, a force, a molecular expansion. The molecules dilate, expand, extend, and when cold, they contract; and since everything is affected by heat or cold, all things are in motion. When two bodies moving in opposite directions strike each other, the motion is broken. What becomes of it? Is this motion destroyed? Not at all, it is converted or enters into these bodies in the form of heat. If, through any unforeseen circumstance, the moon should eventually strike our planet, sufficient heat would be generated by the concussion to melt the globe into a liquid mass. A small rod of cold iron, placed upon an anvil and hammered quickly, will become red hot. I have seen it performed in six seconds—a rapid conversion of motion into heat. Blacksmiths, before matches and tinder-boxes were in use, adopted this method to kindle their

fires. This is heat produced by falling motion. Heat is also produced largely by friction. Fill a metal tube with water, insert a cork stopper in the nose, place it between a lemon squeezer, keep the tube in rapid motion by turning a crank attached to it, and sufficient heat will be produced by friction to generate steam, forcing the stopper out with a gust accompanied by a loud report. A meteor rushes through our atmosphere, and is made red hot by the passage. The friction is so great in most instances by the slight resistance of air alone, meteors are burned before their passage through the atmosphere is effected, as is seen most any night when these falling stars are abundant. Here then is the result of motion, and when motion apparently ceases, it simply passes into heat. Heat is further produced by chemical action. Dilute sulphuric acid with water, and heat is immediately evolved. Mix nitrate of potassa (saltpetre) with sulphur and charcoal, pulverized and dried, and we have gunpowder. Ignite, and a force of the most formidable kind is called into action. This force is called statical, pent-up, or at rest; and by the combination of said substances, when ignited, the static equilibrium is disturbed, the force imprisoned relieved, and the explosion terrific. The motion and heat produced by chemical affinity or action, arise from the contact of two of the mole-

cules, or particles composing them. Heat expands, and cold contracts all substances. Gases expand most, liquids next, and solids the least. The more dense a solid, the less it is effected. Rocks are broken or disintegrated by heat and cold, expansion and contraction.

A stove when first heated snaps and crackles, and again when the damper is suddenly shut, because of the unequal expansion and contraction. Glass is liable to crack when hot water is poured upon it, because the surface heated by contact expands faster than the inner surface, and bending and cracking is the result. Bunker Hill Monument is bent by the sun's heat in a hot day, but the cool of the evening, or a shower, restores the column to its original position. The sun is the great fountain head of heat for our planet, and yet the sun's rays do not warm the atmosphere through which they pass, but are absorbed by the earth and radiated. The rays will pass through our windows without heating or warming the glass, so they will through a sun glass without heating it. On top of a mountain, nearer the sun, it is much cooler than in the valley.

CHAPTER XV.

LIGHT.

Light is the correlative of heat and motion, and owes its existence to the two latter forces. All in fact must originate from one common source. No light is rendered visible to the eye unless the retina is impressed, and something —either matter or wave motion—transmitted to the retina to excite vision. It is difficult for one to realize the fact that, at the distance of the planet Neptune, 2,800,000,000 miles from the sun, something must be transmitted through that immense space to the eye, to enable the latter to observe the planet; and the question was an open one not many years ago whether there is an emanation of matter from the luminous or illumined substances, (whether a star or a terrestrial object), to the retina, or whether there is a thin, elastic, etheral medium filling space, between said illumined celestial object and the eye, subject to pulsations or light waves in the same manner as sound is transmitted from the sounding body to the ear by the vibrations or undulations of air between them. The light vibrations or waves, however, are supposed to move trans-

versely, while the sound-waves undulate longitudinally. The former theory is termed the corpuscular, or emission, expounded by Sir Isaac Newton, while the latter is called the undulatory theory established by Thomas Young, and is the most popular and generally accepted hypothesis. Light travels with immense rapidity. The time occupied in passing around the earth—some 25,000 miles—is scarcely perceptible, for its velocity is about 180,000 miles per second; hence from the moon, some 239,000 miles distant, it takes about a second and one third for its reflected light to reach us; from the sun, 92,000,000 of miles away, it requires about eight minutes; from Neptune, the farthest planet from the sun, about forty-four minutes; from the nearest fixed star, about three years, and from some of the very distant fixed stars, a hundred thousand years or more. That is to say, if one of these stars should in any possible way be blotted instantly out of existence, it would take the length of time mentioned above for us to lose the light, and the fact made apparent to us; and if these stars at the end of that expired time should begin a new existence in the heavens, it would take the length of time mentioned for the light to reach us; as in the latter fixed star alluded to, a hundred thousand years would pass by ere we should detect said star in the starry

vault. White is not a separate, independent color, it is rather a combination of colors. Black is not a color, but denotes the absence of color or light. White light is solar or sunlight, and composes the entire list of colors. Darken a room, and allow a ray of sunlight to enter and fall upon a prism; the light will be decomposed, separated, and the seven beautiful prismatic colors of the rainbow thrown upon a screen placed in the rear part of the room; reverse this experiment by the addition of another prism, and the decomposed light or spectrum will be resolved into white light again, which proves that the latter, or sunlight, is a combination of colors. This is further illustrated by painting the spectrum on a circular disk, revolve it rapidly, and the disk appears white. Stop it, and the prismatic colors appear again. A distinct representative color is produced by the substance upon which the light impinges or strikes, not being able to absorb all the colors; hence the rays rejected indicate the color of the substance. A substance, for instance, allows blue, violet, green, indigo, orange, and yellow to pass through, or absorbs them, but the red rays it will not receive, and consequently these rejected red rays strike the retina, and the substance appears red. Solar or sunlight possesses chemical properties, as is easily demonstrated by the photographing process. A plate is prepared by pour-

ing thereon a solution of bromide or iodide of silver, it is then placed in the camera, and the person or thing to be photographed is placed in position; the solar light, (direct or reflected), impinges or strikes upon the object, which is reflected upon the prepared plate, and decomposes the preparation of bromide or iodide of silver. Take a green leaf or other green vegetable substance, and the salts of silver on the plate will not be decomposed, because the leaf will not reflect the light which it receives from the sun, to the camera, for the leaf absorbs the entire rays impinging upon it; and as none passes through it, nor any reflected, its image is black, showing the absence of color or light. This demonstrates the chemical properties of solar light.

CHAPTER XVI.

ELECTRICITY.

Electricity is another important chain in the link of forces correlated to each other. The existence of electricity in times past was thought to depend upon a certain fluid; but to-day the theory is discarded by most scientists, and the hypothesis accepted that the phenomena is due to a sudden, an unlimited expansion or extension through space of the little molecules composing the substance or substances excited by friction or chemical action—an effort, in fact, like the phenomenon of wind, to restore the equilibrium; one portion of nature possessing too much of the force, another too little; hence the rush or attraction of the positive (the stronger) to the negative (the weaker) that the balance may be restored. Clouds contain a considerable amount of electricity, and when they contract and squeeze out—so to speak—moisture, condensing into drops of rain, the amount of electricity set free, or discharged, is large, and lightning—an electric spark—is seen. When electricity is set free in the air, it enters vapor or clouds again, and thus preserved in the atmosphere. Although dis-

charges are much more frequent between cloud and cloud, yet sparks pass from cloud to earth, at times, as many an alarmed inhabitant of the latter can well attest. Negative electricity of the earth attracts the positive from the clouds, and a discharge to the former is the result. That thunder and lightning are more frequent in warm weather, is due to the fact that under the scorching rays of a summer's sun, a greatly increased evaporation of water upon the earth's surface occurs, which in the form of vapor absorbs a large amount of electricity; and the cooler current above condenses the vapor, liberates the electricity, and lightning is in consequence more frequent. The resistance of air to the passage of lightning is great; hence its zig-zag course in struggling along. Yet its rapidity is almost inconceivable, as it travels at the rate of two hundred thousand miles, or over, a second—faster even than light. Its velocity is so great, should a person be struck with it, his death would be painless, from the fact that it travels so much faster than the information from the injured spots of the body to the brain, death would ensue ere the latter was apprised of the injury. To avoid lightning, some precautions are necessary. Metals are good conductors; hence keep away from them. When out of doors, in a thunder storm, take care and not run under a tree for

shelter, for trees attract lightning, but are not as good conductors as the human body; hence in leaning against a tree the electricity or lightning will branch off from the tree through the body to the ground. Electricity will always leave a poor conductor for a better one, when the conductors are in contact, but will never branch off from a better to a poor conductor; as for example, a person would be perfectly safe to grasp a lightning rod when lightning is passing down, for the iron rod being a better conductor than the human body, it will not leave the former for the latter. Copper is a far better conductor than iron; hence copper tips and attachments to iron rods are requisite. The rods should be perfectly insulated from the house, and terminate in the ground at the depth of ten feet at least, where moisture is permanent. A large number of rods are not only worthless, but render a dwelling less secure, from a lack of knowledge of the dealers in placing them thereon. A tall tree is the better conductor. Frictional electricity is that excited by friction. Voltaic or current electricity is produced by chemical action. The latter is used in telegraphy, because the current is constant or continuous, while the former is intermittant and broken. Frictional electricity would jump several inches from one line to another, should the chance offer itself; while voltaic would travel thousands of

miles before it would jump across or leave the wire. Formerly there were as many wires as letters in the alphabet used to send a message; finally through the Morse system, marks were adopted instead of letter signals, and only two wires used. The current, to be continuous and effectual, must return again to the spot the message starts from; hence an outward and return wire, but through the economy of science and nature, a great saving was made to telegraphy, by discovery that the earth was a great storehouse of electricity, and instead of two wires, hundreds of miles in length, the earth was substituted for the return wire, by sinking a plate at either end in the ground; and lines at present are working with but one wire. Now at the time of writing, experiments are being made, and successfully, with wireless telegraphy. What next?

CHAPTER XVII.

EARTH.

The orbit or path of the earth around the sun is not perfectly round, but elliptical; and although the fact is a novel one, yet it is nevertheless true that the sun is some three millions of miles nearer to us in the winter season, in the northern hemisphere, than in the summer, and why? An ellipse is a flattened circle or sphere, with its diameter greater in one direction than another; and within this ellipse, or orbit of the earth, the sun is situated, not in the centre, but at one of the foci, between the centre and the orbit, in the direction of its greatest diameter; and consequently the earth in its revolution, is nearer the sun at this point of the orbit than the opposite, and the fact of our not experiencing or receiving more heat when the earth reaches this point in its orbit in the month of December, is due to the inclination of our planet to this solar mass, the sun. The rays of the latter, in the cold days of winter, strike more vertically the lands and seas of the southern hemisphere, the sun apparently receding, on the approach of winter, to the south; hence the rays falling upon our northern hemisphere

are oblique or slanting, and though the nearness of the earth to the sun is increased at this time, the slanting or oblique rays do not impart as much heat to the spot impinged as direct, straighter, or more vertical rays. The northern hemisphere receives more heat all the year round than the southern; because the earth is nearer the sun during our winter, while during the cold season of the southern, the sun is most distant from our planet, and consequently their winters are more severe. Their summers are also equally severe, from the fact that, during these months, the globe is nearer the sun; hence intense summer heat and intense winter cold must be their portion should no local disturbance interfere. But that the north receives more heat during the year is due largely to the fact that during the earth's aphelion, (farthest from the sun), its velocity is lessened, and the summer of the north made longer, by some eight days, than the south; while during the winter of the former, being in closer proximity to the sun, the velocity is quickened, and the cold season correspondingly shorter than in the southern hemisphere. That the earth is traveling with immense rapidity around the sun is hardly perceptible to our outward senses. When we ride behind a fast trotter, or in a railway train, we can perceive and measure their speed by the stationary objects—trees, houses, vil-

lages—passed; but, in standing upon the globe, with no trees, houses, villages or other objects in the sky save the stars in their apparently slow and onward march, to compare its swift flight through space, we are bewildered, and doubt the very existence of self, when the astronomer tells us that we are moving around and around upon the Earth's axis, at the rate of one thousand and thirty-eight miles per hour, and at the same time moving through space around the solar mass some sixty-eight thousand miles an hour, or sixty times faster than a ball shot from a cannon's mouth! But, through the intelligence and mechanism of the age, instruments have been devised to assist our unaided eye, and what the astronomer or mathematician gives us is no longer a matter of speculation, but a clearly demonstrated fact, and must be appreciated through the realms of thought, and not through the channels of our own individual unaided senses alone.

CHAPTER XVIII.

MOON.

The earth possesses what no other planet between Jupiter and the sun can boast, save Mars, and that is the possession of an attendant, a moon. Our nights are rendered enjoyable and priceless, with this blessed boon to guide our footsteps in the grim and shadowy darkness; but alas! for our celestial offspring, would that we could transmit to her the blessings of earth, with its boundless variety; but its conditions are probably too mature for the enjoyment of an inhabitant. When the question arises, whether our satellite is inhabited, our answer is probably not, at least, we pray not, for the inhabitants' sake; for a globe without water and air must of necessity render it a very undesirable place for organisms possessing similar structures to our own, or any structure that is possible for our finite minds and fertile imaginations to picture. The most powerful telescopes have not been able to detect a vapory envelope or semblance of water upon the lunar mass; and a cloud but 200 yards in extent could be easily seen if it had an existence there. "In consequence of this want of atmosphere," says Proctor, "none of

those effects of light, of those cloud-tints which give our terrestrial landscapes so much charm and softness, are to be seen there. There, refraction does not decompose sunshine into glorious coloring, and a thousand varied tints; the rainbow is unknown on the surface of the moon, but then the stars and other celestial bodies shine in full day in the starry vault. The absence of air and water implies the absence of winds and currents; absence of motion everywhere, in the sky as on the surface. At the most, under the influence of the alternations of heat and cold, the disintegration of the rocks and the destruction of equilibrium of the heavy bodies, causing the fall of debris, break the monotony of the stillness and eternal silence. Nor sound, as it cannot be communicated without an aerial medium, can only make itself known by the contact of solid molecules." "To an inhabitant of earth our light giver by night would appear," says Humboldt, "but a silent and voiceless desert."

The earth's attendant is new when in its perihelion, or when it passes between us and the sun; the bright portion of the moon being simply the light thrown upon it by the sun. When the former passes between us and the latter body, the bright and illumined parts of course are toward the sun, while the opposite side presents to us the darkened portions; the sun's rays being able to

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reach but one side at a time, the same as an apple placed in a room between an observer and a lighted candle; he cannot discover the light thrown upon the side of the apple nearest the candle; all he can see is the darkened side nearest him, which the light rays cannot reach and brighten. Now if the apple is placed just a very little one side, say about five degrees in a circle, the observer will perceive a small portion of the apple brightened in the form of a crescent; so it is with the moon when new; she rarely passes directly between the sun and us, where a straight line would pass from the earth, through the centre of the moon to the sun, for in that event a total eclipse would be the result, and would occur at every new moon, and again when full; but it travels mostly in its revolution around the earth a little one side of said straight line when nearing the sun, and consequently a small part of its brightened side is seen, crescent in its form as just described in the apple illustration. When the apple, which we placed between the observer and the lighted candle, is revolved around the former, it recedes from the candle, and arriving at right angles of said observer and the candle, the light rays from the latter, of course, will illuminate one half of the apple; but one half of the illumined portion only is visible, and applied to the moon it is what is called the moon's first

quarter. Now as the apple continues to revolve around the observer, receding further and further from the candle representing the sun—until it arrives nearly opposite the latter, one half the apple as usual is brightened, and the observer continuing in his seat, being between the two, observes the entire illumined portion, and applied to the moon, it is termed the full moon, one half of the moon being brightened by the sun's light; and not only the new, the quarter and full moon are thus explained, but all the phases of the moon in its revolution around the earth, whether receding from or approaching toward the sun. Our satellite, when full, gives three hundred thousand times less light to the earth than the sun. Its surface as viewed through a telescope, presents a mountainous region; some of the peaks in the Appenine range reaching over four miles in height. The ruggedness of these mountains with the cragged and precipitous rocks, bear some resemblance to the Alps. The bright parts observed upon the moon's disk are the elevated portions, the small spots or dots, the mountain peaks, and the dark portions are the plains and valleys, some of which are three miles deep and forty miles wide.

The moon has been the seat of terrible volcanic actions, for the large part of her surface is made up of huge craters, some of them a hundred miles in

diameter, much greater than any upon the earth, the largest here being but about twelve miles, and our globe is some forty-nine times larger in volume than the moon. A small hand telescope will reveal to the observer, when directing his glass to the new moon on the inner side, these innumerable craters—small, ridged holes, looking something like a piece of tripe—covering a large portion of the inner edge of the illuminated disk. It is the opinion of some physicists, as small planets must cool, condense, and develop faster than large planets, (there being less mass to expend the heat from), that the moon, being so much smaller than our globe, has expended more of its heat, developed more rapidly, supported life in ages past, and having spent all its energies, it is now in the turning or waning period of its existence.

The nearest that the most powerful telescope has brought the moon to us, comparatively speaking, is within about eighty miles, while the real distance from us is about two hundred and thirty-nine thousand miles. Any object measuring two hundred feet is observed on its surface. With the million dollar telescope, it is thought the moon will be brought within seven or eight miles, comparatively, to view; but even at this near proximity the question cannot be settled whether it is inhabited with beings like ourselves or not, for

although life might be discerned by the moving of large congregated masses, the precise form of a man or any single being could not be distinguished or recognized; especially when we recollect the fact that the moon is many times smaller than the earth, and the objects on every planet, in obedience to the laws of gravity, must correspond to the size of the planet on which they rest, so that a fair sized man of one hundred and fifty pounds upon the earth would be represented upon the moon by one of about eleven or twelve pounds; an infant compared to the earth man.

CHAPTER XIX.

EARTH IN SPACE.

Could one stand upon the moon and view the earth revolving, with other planets around the centre of our system, he would realize the fact that it was simply a huge ball moving in the starry firmament with that apparently slow march across the sky, from the rising to the setting, that governs the other heavenly bodies in their motions through space. From the moon our planet would appear many times larger than the former does to us, giving the same light to the moon, only very much greater. This light, however, like the light from the moon, is reflected light, and it seems almost incredible to the uneducated, that the earth with its dull surface, covered with soil, rocks, vegetation, water, etc., can reflect sufficient light in space to illuminate the night of our satellite many times more than the latter sends to our planet. The bright moon, which furnishes so many subjects for the artists to portray, and the poet to immortalize himself, is nothing but a mass of dull earth, with jagged rocks, like the globe we inhabit, and which, although dull and jagged, is able to reflect the sun's

light into space, the same as our faces and our dress, or the dull surfaces of the ground, trees, and buildings of the homestead reflect sufficient of direct or indirect light from the sun upon the camera to be photographed upon paper and preserved for our future gaze. The light reflected from the moon or the earth, however, into space, is spent so far from the former to the latter, and the latter to the former, or planet to planet, that either globe appears as a ball or disk of light, dim to the observer upon the spot, but as he retreats farther and farther into space, therefrom, its scattered rays appear closer, blend and concentrate into smaller space. On a new moon one can readily observe during a clear night, the reflected light from the earth upon the darkened portion of its suface; this part of the disk is considerably lighted up, but would be completely darkened, so that the outlines could not be traced if not partly illuminated by the earth's light.

The revolution of the earth around the sun and upon its own axis is explained by the following hypothesis; the earth and all the planets as explained in the first portion of this work are supposed originally to have belonged to a vast nebula, or gaseous mass, with the sun as the central portion; the nebula began to condense, and the outer mass separate in the form of rings, and the rings in turn condensed, each of them, into a ball or

globe. The impulse or motion given it when separating or thrust from the central mass continues, because there is not sufficient substance in space to obstruct its march; the same as a ball, if tossed in the air would continue in motion forever, if its passage were not obstructed by the comparatively heavy atmosphere, and the earth's gravitation.

When the earth was thrown off the central mass, it would have continued in a tangent direction, obeying the centrifugal force; but the central mass, the sun, being such an enormous body—some fourteen hundred thousand times larger than our planet—it exercises a powerful attraction to the thrown off globe, and instead of leaving in a straight line its realms forever, the little earth is obliged to obey the laws of gravitation, and while its tendency is to fly off in a tangent direction, the sun's attraction is constantly pulling it toward itself, like a horse trained by his master in the ring. He is inclined to run in a tangent direction, or a straight line from the latter, but the long and tight rein checks his straight course, and the master pulling one way, and the horse the opposite; while in motion, the course of the latter is necessarily a circle around the former, who occupies the hub, so to speak. So the earth in the same manner is held in check, and while in motion must obey this centripetal

force, and travel around the sun. If its motion should cease, the centrifugal force is at an end, and, the centripetal preponderating, its precipitation into the sun would be immediate. The rotation of our planet upon its own axis is supposed to be due to the motion of the ring around the central mass, which, when condensing into a globe, preserved the same rotary motion around itself. This motion which turns the earth upon its axis is difficult, at first thought, to comprehend, for it would seem with our narrow earthly experiences, that if we remained at rest on one spot upon the globe, when the latter revolved halfway round, our heads instead of being up as usual, must be down, and our feet up, and thus we should fall or drop off the earth into the depths below; but when we think a moment, we see that throughout the vast realms of space, there is no up or down, being just as much up when the earth has revolved half way on its axis, directly opposite—or downward, improperly speaking—as when apparently uppermost, for gravitation holds us firmly to the globe, and the starry firmament is as real and visible above, below, and around us, whatever our position upon the earth during its rotation.

CHAPTER XX.

MOON AND THE WEATHER.

Has the moon anything to do with the weather upon the earth? We think it has. All scientists are agreed that the moon's attraction is largely the cause of tides upon the earth. A cursory investigation of this phenomena will be necessary to aid us in our research. All bodies in the heavens are attracted towards each other in proportion to their size and distances. If it were possible to find a stone larger than the earth, somewhere near its surface, in space, the earth would fall more towards the stone, than the latter towards the earth. Tip a rock over a precipice, and the earth will move towards the rock, while falling, in proportion as the size of the earth is to the size of the rock; hence it follows, although the moon is much smaller than the earth, yet it attracts the latter towards itself in proportion as the size of the earth is to the size of the moon; the force of attraction of the latter upon the earth is sufficient to pull the earth to itself the distance of two thousand miles. Now the moon's attraction of that particular point or side of the earth presented, during its rotation on its axis nearest to

our satellite, is greater even than the attraction of the sun, although the attraction of the latter for the earth as a whole is vastly greater than the moon's attraction; hence the water upon the earth being a liquid, and far lighter than the solid portion, is easier attracted by the moon on that portion of the earth's surface turned towards it; and regarding the ocean covering three-quarters of the earth's surface, as one huge drop of water, the moon's attraction in pulling the water toward it, elongates the drop. The ocean being distributed over so large a surface of the earth, (25,000 miles in extent, and 8,000 miles through the globe, from the easterly to westerly portion), the moon's attraction is not sufficiently powerful to pull the waters on the opposite side of the globe towards itself, and hence the elongation of the huge drop of water, which we call the ocean, the portion of it on the side facing the moon, and the nearest to it, is pulled or drawn towards it, which accounts for the high tide on this side, it being on the end of the huge elongated drop; while the waters between the two ends of said elongation must necessarily be shallow or low, which accounts for the low tide on both sides of the earth between the portion facing the moon and the side opposite; and the elongated end on said opposite side of the globe will also explain the cause of the deep waters or high tide on that portion, making

two high tides and two low tides on the opposite parts of the earth at the same moment. We are now prepared to study the hypothesis which I am about to advance in relation to the influence of the full moon upon our weather. The atmosphere surrounding the earth is a substance, as much as water, only not as dense; its weight is many thousands tons. There are tides of atmosphere as well as water, only the former are far greater than the latter, because a light substance is more easily attracted than a denser substance. A storm is approaching a week before the full of the moon; it continues until the moon fulls, and then generally ceases. Why is this? It must be due to the same reason that causes the tides of the ocean to rise and fall; the moon attracts the clouds and pulls them, as it were, towards itself, and much more at the full of the moon, and when new, than any other phase; the same as it attracts the waters more at its full, and new, and why? It is well known that the sun attracts the waters of the earth, as well as the moon, but not as much, the sun's attraction being in the ratio of about one third to two thirds of the moon; hence when the moon is full it is on one side of the earth, while the sun is directly (or nearly) opposite on the other side, and as both are on the same line or plane with the earth, both the sun and the moon attract or pull the huge drop of water called the

ocean, on opposite sides; hence the elongation of the drop is far greater, and the tides much higher, than when these heavenly bodies are not on the same line or plane, and directly opposite. Hence it will be observed that the full moon will attract or pull the clouds away from the earth more than any other phase, and consequently the clouds being farther removed, are more likely to become scattered and broken; hence when this takes place the storm must of course necessarily abate.

CHAPTER XXI.

ECLIPSES.

The eclipse of the sun and the moon have, in years gone by, been the cause of some fright to the superstitious and uneducated, but as time has marched on, and civilization has advanced, the laws of nature and its phenomena have been more generally understood, and now every well informed man and woman knows the eclipses are governed with as much regularity as the journey of the planets around the sun. The appearance of the eclipses are foretold with as much accuracy as the coming to view of any planet in the heavens. The eclipse of the sun is due to the moon getting directly in line between us and the sun; and as the moon is apparently about the same size in the heavens as the sun, it covers up the entire disk and presents a dark object, and in reality we are looking at the moon and not the sun. It gives the astronomers a fine chance to study the chromosphere and the photosphere of the sun, for as the moon covers up only the main body of the solar mass, its atmosphere or the corona flames all around the rounded form of the eclipse are seen through the telescope, and the

changes that have occurred since the previous eclipse can be noted and recorded. We should have an eclipse of the sun at every new moon if the latter traveled in a direct line between us and the sun, but as it does not, an eclipse is rare. When the moon is full and the earth is between the sun and the moon in direct line, we have an eclipse of the moon, which is simply the shadow of the earth the sun casts upon the moon; and this phenomena would occur at every full moon if the earth passed in direct line between the sun and the moon.

CHAPTER XXII.

SOLAR SYSTEM.

Passing to other bodies in the solar system, we find eight primary planets, two of which are between us and the sun, and are called the inner planets; five lie beyond the earth's orbit, and are termed the outer planets. One half of the planets nearest the sun are much smaller than the other half, and also differently constituted. The outer half are blessed with numerous satellites; Mercury is the smallest primary planet in the solar system, being several times smaller than our globe.

Its day is nearly the same length as our own, while its year is only about one quarter the length. Its surface is uneven, one mountain reaching the height of eleven miles, while upon our own planet the highest mountain does not reach six miles above the level of the sea; and considering the earth is so much larger than Mercury, the elevations on the latter, transported to our own planet, and proportionally increased, would be frightful to the timid to observe. The question of Mercury being inhabited is unsettled. Its nearness to the sun, thirty-seven million of

miles (the earth being about ninety-two and a half million) almost precludes the idea, for the heat must be intense; and as the sun is not directly in the centre of Mercury's orbit, the heat at one portion of the year is about ten times that received by the earth, and about four and a half at another season. It is possible, however, that differently constituted beings may exist there, able to stand the heat, concerning whom we can have no knowledge or conception.

As I have already given a description, though brief, of the planets in the Solar System in my recent work on the birth, development and death of our planet, entitled, "Breaking Up," I will only refer to them in a general way. Venus, a neighbor, being nearly the size of our own planet, but nearer the sun by one third than the earth, presents a different problem as to its inhabitancy. Take the torrid zone, for example, on our own planet, with the temperature increased thirty-three per cent., it is quite a question whether or no our inhabitants could thrive with such increased heat; some might live through it, but would the larger part multiply, grow, and hold their own? Again, take the temperate zone where the sun is nearest us in summer, the temperature reaching from 90 degrees to 100 degrees Farenheit, making with the increased heat, the temperature from 125 degrees to 130 degrees Farenheit, we could

stand it in the winter, but how in the summer? we might live through it, but it would be frightfully uncomfortable, to say the least. If the inhabitants were constituted with like organisms as ourselves, they must have a pretty hard time of it, and yet who can tell whether their environments and their organisms may not be entirely different from our own. It is barely possible that the atmosphere enveloping Venus may be much denser than ours, and if so, it would shield them much more from the hot rays of the sun than our rarer atmosphere would us. But with the aid of our most powerful telescopes, astronomical observers have not only been unable to detect an inhabitant of any description, but have not been able to detect anything indicative of life upon the planet.

It is true, however, that these two inner planets are always in the neighborhood of the sun, so near that astronomers have difficulty in making clear observations of them, the sun's light being too bright and dazzling; hence it is not an easy matter to determine the nature and condition of things on Venus and Mercury as upon Mars and other outer planets though much farther from us. The transits of Mercury and Venus across the sun's disc when in direct line between us and the sun is an interesting event to astronomers, and this can only be detected in the day time, after the sun has risen, when a rounded speck as

large apparently as a walnut can be seen moving slowly across its surface. These transits cannot always be seen all over the world at the same time, for when observable here in United States, it may not be seen in South America, and the reverse, when observed in South America, it may not be seen here; and this obliges astronomers at the north to travel thousands of miles to make their observations. Mercury is not easily detected with the naked eye, owing to the nearness and the brightness of the sun. Venus, as a morning and evening star, presents one of the finest and brightest features of the starry heavens. It must be a morning or evening star; always following comparatively near the sun, never higher at evening than 45 degrees from the horizon, going lower and lower evening after evening as it approaches its phase of a morning star.

CHAPTER XXIII.

MARS.

Mars, the nearest outer planet to our own, is easier of observation, furnishing a fine field for study. There are some grounds for believing this planet is inhabited, and that the planet being considerably smaller than our own, it contributes to the belief in the minds of some astronomers that it is riper, more mature, and telescopic observations of its surface seems to strengthen that belief. In the first place it appears to have an atmosphere surrounding it, which is to our minds a necessary condition to life upon any planet. It does, however, seem to lack an abundance of water, which we are blessed upon the earth, and the only method with which they can be supplied, to any large extent, is by irrigation; this it is thought is being done, as extensive lines are discovered upon its surface, which indicate canals, lines running the entire length parallel with each other, not like rivers with lines or banks irregular. That there have been large bodies of water upon its surface there cannot be much doubt, for extensive water basins are observed, but no great amount of water in

them. The drying up of its waters seem to indicate that the Martians have seen their best day; that their planet is growing old, not too mature for inhabitancy, but in that stage of ripeness, aye, over-ripeness, that its inhabitants cannot enjoy the opportunities enjoyed by the Martians during the development or growth of the planet. Already indications are observed upon its surface, of not only the drying up of its waters, but of its soil or earth. It is exhibiting, so some late observers tell us, a shrinkage, a withering, or wrinkling process going on; something similar to the moon, which long ago, in the minds of most astronomers, became as before stated, unfit for inhabitancy. Snow appears abundant around either pole, and during the warm seasons of the year, by the disappearance of large prominences, there must be great quantities of water flow from these mountains of snow.

The discovery of the two satellites of Mars, but a few years ago, was quite an event in the astronomical world. Not only were astronomers, but the people at large were interested, and many of the masses went so far as to say that they discovered, or, perhaps, better, observed the two moons alone through a piece of common window glass; and it was with considerable difficulty that we were able to dispossess them of the absurd notion, and convince them it was an optical il-

lusion, appearing to be two moons, from the fact that the thickness of the window glass exhibited two light dots, one on the surface, and the other refracted below on the other side of the glass, a little one side, and in reality only one light. It took years for Prof. Hall to discover these moons, and years of labor for other astronomers, who did not succeed in detecting them with their huge, costly telescopes; and yet no doubt there are people to this day who continue to believe they observed "Mar's Babies" through a piece of ordinary window glass, which does not contain the smallest fraction of magnifying power. Mar's satellites are extremely small, not over ten miles in diameter, no wonder they were not discovered before, even though thirty to forty foot telescopes were then in use. They have a regular orbit around their parent Mars, and make their revolution in regular periodic times. When we realize that our moon is two thousand miles in diameter, and Mar's moons only ten miles, the light at night shed by them on their planet must be very small compared to our own lunar neighbor.

CHAPTER XXIV.

ASTEROIDS.

The asteroids, numbering over four hundred, are observed between the orbits of Mars and Jupiter. It is not many years ago that only a few had been discovered, but of late years the numbers have rapidly increased; later discoveries, however, have been nothing but small masses. The size of these asteroids run from one hundred and twenty miles in diameter to a small rock. The larger part of them are small. They travel in regular orbits around the sun, as regular as the earth, Mars or any other planet. There are several theories in regard to the cause of these small planets revolving in space around the sun, and all continuing their revolution in the same path, or nearly so, year after year without any apparent change. The most popular theory is, that long before the era of man or any life upon the earth, a huge planet revolving in the above path or orbit referred to, exploded, and the hundreds of small planets discovered in this region are the fragments of that exploded planet. Their continued motion in their orbit around the sun, is due to the momentum acquired when united as

one in their parent planet, and the law of gravitation or attraction of the sun. Spectrum analysis through the spectroscope has proven the composition of the asteroids to be similar to that of the earth, and if no animal life exists there, it is the opinion of some that plant life finds a home upon some of them.

CHAPTER XXV.

JUPITER AND SATURN.

That great planet, Jupiter, next attracts our attention. It is the largest planet in the Solar System, one thousand and three hundred times larger than our earth, and is over three hundred times heavier; although so much larger, it is not, as will be observed, near as dense. Some observers think it is in a gaseous state, others, that it is denser, but probably it is not heavier than water. The bands seen across its surface, as we have observed them, does not indicate in their changing movements, anything of a solid nature. The four moons of Jupiter are conspicuous in the heavens, even through a small telescope; Galileo discovered them through as small a telescope as many amateurs use in their common observations. They are not always in view, as we found last winter through the great telescope at the Naval Observatory at Washington. Only one could we then see, the other three were in line on the other side of the great planet from our locality, or in its shadow. [Reference is given to my previous work already alluded to, as to the inhab-

itancy of these satellites, and the non-inhabitancy of the parent Jupiter and other features.]

Our next is Saturn. [We would again refer to our latest work heretofore mentioned for a general description of this beautiful planet, its satellites and rings.] The realms of space are being so constantly searched and investigated in course of years; the complexion of things in the starry heavens are so changed from preconceived notions, that statements made but a little while ago have to be amended to meet the advanced theories of to-day.

The hypothesis to-day advanced in relation to the rings of Saturn is, that they are not a gaseous, or a liquid mass as formerly advocated, but are made up of meteorites, aggregated together, similar to the meteoric ring around the sun, through which we pass in our orbit near the middle of August and November when the meteors, often called shooting stars, are seen more abundantly than at any time during the year. It is supposed we pass through them at the upper or lower portion of the ring in August, and emerge from the other section opposite in November. Saturn's rings composed of these meteorites, may be solid, and they may not be. If not solid, it is possible at some future time they may draw closer together and coalesce into one homogeneous mass, and, in that event, it is possible in the course

of time for the rings to break, and the detached masses in their separate capacity close up still closer and form a globe, or rather globes, adding to the already numerous satellites revolving around the great planet.

CHAPTER XXVI.

URANUS AND NEPTUNE.

Uranus and Neptune are the farthest planets in the Solar System. There has been no event in the astronomical world that has proven the accuracy of this long ago supposed speculative science as the discovery of the planet Neptune. Prof. Adams, of England, and Prof. Leverrier, of France, found that the pertubations of the planet Uranus was very great, so great that there must be some planet beyond its orbit, attracting and disturbing it in its regular path around the sun, and accordingly each, unbeknown to the other, made mathematical calculations as to the force of attraction at a given distance, and other complications that entered into the problem. It was a difficult problem, and a long one to solve. No planet had yet been discovered beyond Uranus, through any, or all, of the powerful telescopes then surveying and exploring the heavens. Even the great Hershel with his powerful telescope, with which he discovered Uranus, could not discover any planet beyond, causing the crooked path made by his planet. On and on these two astronomers worked until they had to

their minds solved the problem; and each at the same time not knowing what the other was doing, directed Prof. Galle, of Germany, and an observer at Cambridge, to point their telescopes to a certain place in the heavens, and look for a planet in that locality; they followed out their directions, and found to their surprise, a planet within a degree and a half from the spot indicated by both of these bright astronomers, and this was the manner and the only way that Neptune was discovered. Discovered by the solution of a purely mathematical problem, from a knowledge of existing planetary disturbances, or perturbations, in their orbits, and of the known laws of gravitation.

CHAPTER XXVII.

COMETS.

The approach of a comet in the heavens to view, has been the terror not only of the uncivilized world, but of the civilized as well; but when the people become better acquainted with the composition and the laws governing their movements in space, they will have less cause to fear the appearance of these "Will-o'-Wisps" in the starry vault. Their tails which in some instances cover a space of a hundred millions of miles, are so thin, that in the opinion of Tyndall, their substance could be concentrated in an ounce vial. All astronomical observers can easily see through them, stars beyond. Lockyer thinks they are made up of swarms of meteors, or rather meteoric dust; and that the particles composing them are some distance apart, which enables the observer to look through the homogeneous mass. They are very erratic bodies, sometimes appearing in the firmament unannounced. Others are regular in their coming and going, appearing once in so many years. We have another instance of the remarkable accuracy of astronomical predictions of stella phenomena in the heavens, in the appearance of comets. Halley,

in the year 1682, observed a comet approaching us. He studied its appearance and movement in space, and predicted that seventy-seven years from that time it would return again to our view. "I shall have departed beyond before that event, but it will surely return," he said; and in exactly seventy-seven years from that time, in the year 1759, to the extreme gratification of all living astronomers watching for its return, it made its appearance, and periodically every seventy-six years thereafter it appeared, and will again return in the year 1911. There are several comets that make their appearance in regular periodic times in the heavens.

Donati's Comet appeared in 1858. This was a large comet, and excited great attention when discovered in the heavens. This comet has a parabolic orbit, and will not appear in our heavens for nineteen hundred and fifty years, making us a visit in the year 3808.

Enche's Comet is a noted comet, being discovered in 1786 by Enche. It is a short period comet, occupying only three and one third years in performing its revolution around the sun. There is no comet, perhaps, that has caused more discussion concerning its movements in the heavens, than this comet. It has had the reputation of shortening the length of its orbit, or the time occupied in the performance of its journey

around the sun, and some authorities predicted that if this shortening process continued in each revolution, there must be a time when its orbit would draw very near the sun, and ultimately fall into it; but assuming that its orbit continues to grow shorter year after year, and its approach becomes in close proximity to the sun, what is to prevent the same influence in regard to this comet in becoming so fully charged with electricity, (as with other comets at their near approach), that a repulsive action will take place, and send it off again with great rapidity into space. The observations, however, made of this comet in recent years, seem to fail in detecting any shortening of its orbit, or time, in traveling around the sun. The great comet of 1843, which was visible in the day time, was a noted comet. It attracted a great deal of attention for its large size, it being a very conspicuous object in the starry vault. It approached very near the sun, so near it was feared it would fall into it; no comet was ever known to have approached as near, and when its period of revolution around the sun is known to be five hundred and thirty years, what a vast distance beyond even the farthest planet in the Solar System, Neptune, which is so far, that it takes in performing its orbit around the sun one hundred and forty-four years, and yet this great comet in its aphelion is

nearly three times and a half farther, and in its perehelion movement it approaches vastly nearer the solar mass than the nearest planet in our system. This comet will not make its appearance again in our heavens until the year 2373. The next comet of note, and the last one among many we shall mention at this time, is Biela's Comet, sometimes called the lost comet. This was discovered by Biela in 1826. It has a short orbit, occupying only six and two thirds years in its revolution about the sun. It has made its appearance regularly every six and two thirds years since its discovery, until the year 1846, when it was found that it had met with an accident, for in place of one comet, it had split in two parts, making two comets, one larger than the other; their distance apart increased with age, reaching some one hundred thousand miles. In 1852 the entire comet, (both parts), were lost to view, and although it should have made its reappearance some seven times since that period, it has never been seen since, and hence it is called the "lost comet."

[Ed.—Their movements in space I have in some detail elaborated in my previous work alluded to.]

CHAPTER XXVIII.

INTERPLANETARY SPACE FORCES.

The laws of gravitation as applied to all bodies in the heavens is already questioned by some physicists.

[Ed.—Some 25 years ago I was first to advance the theory of repulsion having something to do with the movement of bodies in space.]

I have attempted to prove in my former work that comets in their movements in the Solar System, and their path around the sun, seem to be governed by the laws of repulsion as well as by attraction or gravitation, for when the comets approach the sun, and in some instances are drawn very near; their tails instead of being further attracted to it, will switch around to the other side of the nucleus of the comet, farthest from the sun, in its near circuit around its mass; and instead of falling into the sun as it is speeding with immensely increased velocity towards it, and seemingly impossible to escape the apparent catastrophe, it skips around and off again into space, and this is due to the law of repulsion, and not of attraction or gravitation. In other words it is electricity that governs it, and not gravita-

tion, the same as the pith ball placed in near proximity to the prime conductor of an electric plate machine, it is at first attracted to it, but when filled, or charged with electricity, it is repelled and forced from it, and why does not the law of repulsion have as much to do with the movements of the planets in their paths around the sun, in keeping them at their proper distance therefrom, as the law of gravitation in drawing or attracting them towards the solar mass, or in other words does not the law of electricity, in its attractive and repulsive force, have more to do in keeping the planets at their respective distances in their orbits around the sun than gravitation? Take for example the comets I have mentioned, the great comet of 1843, whose perehelion was so near the sun it was feared it would fall into it, but did not, and why? because it could not. In its approach to the sun it became so charged with electricity, the sun lost its power of attraction, gravitation had no longer any influence upon it, the law of repulsion began to operate, the centrifugal force began to control it, and the centripetal had lost its power, and the comet passed off and away from it in a tangent, as rapidly as its approach. This is precisely what we should expect it would do, if electricity exercised any control over it. Take Enche's Comet, notwithstanding its orbit was approaching nearer

the sun at each revolution for several years, it suddenly ceased its nearer approach, and probably never again will it shorten to any great extent its orbit. If it should it will never fall into the sun as it was once feared, for it cannot, as it is undoubtedly charged with sufficient electricity to keep it at a proper distance, and if it should ever revolve too near, it will become so much over charged with electricity, the repulsive force will become a potent influence, and will send it farther into space than it has ever attained, and with greater rapidity. If this is true of comets and planets, why not true of the stars, the suns and all sizeable bodies in space? The recent discoveries of Nicola Tesla of the power of electricity, in high altitudes, away from the earth, where an electric current can be more easily controlled than upon or near the earth, where this force is more powerful than here on the surface, is a prominent factor in the solution of this problem. He expects to find, and has already found, that the electrical current can be sent from an electrical plate in the rarefied air regions to another plate in the distance without the assistance of any wire to conduct or transmit it. If then it is found that electricity has greater power in high altitudes where the air is more rarefied, is it not possible, aye, and I might say, probable, that electrical currents continue to exercise the largest con-

trol in the interplanetary space, and through all space. Light, heat, and electricity may proceed from the same force, possibly are one and the same force. Electricity travels with nearly the same speed as light, some two hundred thousand to one hundred and eighty thousand miles a second. Light is transmitted by wave motion from the distant star, or from the tallow candle in the confines of your room, so is electricity, and so is heat, as one can easily observe on a hot summer's day as it rises in trembling waves from the heated, sandy plain. Far be it from me to say there is no such thing as gravitation, for this force does exist, exist, perhaps, in a larger sense under the name of electricity, which not only has the power of attraction, but carries with it repulsion; a positive and negative influence. Take for example a "thunder cloud," so called, a couple of them, one is more charged with electricity than the other; the one fully or over charged, is termed positive electricity, the other with less electricity, is negative. Nature always seeks to restore its equilibrium, and hence the positive cloud empties its surplus of electrical force into the negative, and the equilibrium is restored. If the earth is more charged with electricity than the clouds, as is sometimes the case, the electrical current instead of passing from the cloud to the earth, will pass

from the earth up to the cloud; but I should expect under the same circumstances that if one cloud was very, very much larger than the other, the small cloud not being big and dense enough to receive all the surplus energy of the positive cloud, would become over charged, and the repulsive energy would at once begin to work and move farther away out of the influence of the mammoth cloud. And the same phenomena I should ascribe to the positive influence of the sun over such light bodies as comets, or other light and smaller bodies as the planets, in interplanetary spaces. Even the enormous mass of invisible meteorites said to be falling into the sun and earth to the number of thousands and millions daily, if the attraction is greater than repulsion, it only illustrates that in such extreme cases, where the difference in size is so enormously great, gravitation or attraction has a greater influence over them than repulsion, and they remain.

CHAPTER XXIX.

THE FIRMAMENT.

The next for us to consider is what constitutes space, and by space I mean not only interplanetary, but interstellar space, all space between planets, the stars and all recognized bodies in the starry heavens. Nature abhors a vacuum, and can it be less true in the vast realms of space above, than upon the earth where we dwell? I am aware it has generally been advocated in past years that there is nothing whatever existing in the interstellar space, but of late there has been a question in the minds of some savants, whether or no this can be true. In my own mind I have not a doubt of the existence of some form of matter in space. This hypothesis I advanced a quarter of a century ago. Call it ether if desired, but there must be something, though greatly attenuated, filling all interspace. There is one thing certain, either the undulatory hypothesis of light by Young is untrue, and the emission theory of Newton is right, or space is filled with some substance, call it what you may. How is it possible for light to be transmitted, or, in other words, journey from a distant star, or from the nearest

body in the heavens, the moon, to us here on earth, unless there is something for the light to act upon and produce the light waves, moving transversely as is claimed by the undulatory theorists? there must be some form of matter there, else the light waves cannot be detected.

Some savants claim that all inter space is filled with small fragments traveling here and there at will. Lockyer, the eminent English astronomer, advances the theory that through the interplanetary and interstellar spaces are collisions occurring constantly between comets, meteors, and all erratic bodies, and the light from them is due to these collisions. The mass of these meteoric fragments is not more than one five-thousandth part of the earth's density.

He is of the opinion that variable stars are not like our sun, but are made up of meteoric swarms, like comets, clouds of incandescent stones, but more condensed than nebula; and that double stars began from double nebula, developing and condensing into double stars, one revolving around the other, the larger one, on account of a larger volume, requires more time to develop and condense than the smaller.

The nebula existing in space is generally supposed to be composed of gaseous matter, and that our own Solar System and other solar systems began to develop from these nebulous masses.

There are easily seen in various constellations in our northern hemisphere. A prominent one in Orion we easily detected with a telescope of our own mounting, two and one fourth inch aperture. The milky way is generally conceded to be made up of small stars, invisible to the naked eye. Hershel, the elder, directed his forty foot telescope to the milky way, and within the space of fifteen minutes, counted in blocks, one hundred and forty thousand stars pass his telescope without moving it. There are a great many apparent empty spaces in the milky way, and in some of them nothing can be detected, even by the aid of telescopes. Star clusters are numerous in the heavens. Perhaps, the most conspicuous one is the Pleiades cluster in the constellation of Taurus. Here the unaided eye, under good conditions, can detect seven stars, ordinarily only six, but by the aid of a good telescope a cluster of two thousand can be detected. It is a beautiful sight even by the aid only of a very small telescope, where it presents to view a score or more of brilliant diamonds sparkling in the sky. There are plenty of other clusters, which by the aid of a small glass can be detected in the constellations. Large and bright stars are thought by some to attract, by gravitation, lines of small stars following in their march through space, stars from the eighth to the sixteenth magnitude. They appear

to be in streams, sometimes in ovals, and other instances in ellipses and circles, the milky way being made largely of these clustered forms. The brightness of a star does not always determine its distance from us. For example, Vega and Sirius are very bright, and apparently nearer us because of their brightness, but in reality they are very much more distant than sixty-one Cygni, a very faint star in comparison; yet the majority of bright stars are nearer than stars giving a faint light. Our sun seen at the distance of the above stars mentioned, would be a rather faint star, being in the class of the sixth magnitude. The eminent astronomer, Kepler, who died in 1631, thought the universe was divided into three parts. Our sun one part; the planets and the interplanetary spaces a second part, and the space beyond the Solar System, the third part, which he termed a frozen starry vault.

The distance between Neptune and the nearest fixed star—a centauri—is estimated to be nine thousand times the distance of Neptune from the sun, the latter being 2,800,000,000 miles therefrom. This enormous distance between Neptune and the nearest fixed star is apparently void of any moving thing, a space estimated at fifty billion miles. A space four thousand five hundred times larger than that occupied by our Solar System, including not only the distance of all the

planets from the sun, but their paths or orbits around the sun, which doubles the space mentioned. Notwithstanding the extreme heat given out by our sun, there are other suns hotter, as there are many much larger, and size has considerable to do with the amount of heat expended by any sun. Sirius, the dog star for example, is very much larger, and very much hotter; it is about 2,000,000 miles in diameter. A smaller planet or a smaller sun will expend its heat much faster than a larger body; the same as upon the earth a small amount of matter will expend its heat much quicker than a greater amount.

To an ordinary observer, on looking up to the starry heavens and judging, without enumerating, the number of stars in the firmament, he would at first say there were some hundreds of thousands visible, but in reality but about 7,000 in the northern and southern hemisphere can be enumerated by the astronomer's unaided eye; and an ordinary observer, in enumerating them, would fall considerably short of that. It must be understood that one cannot stand at any one spot in the northern hemisphere and count seven thousand, for he can see at one time only about one half of the heavens, and it is for the observer in the southern hemisphere to count the other half. Although one can count some coming to view from the southern

hemisphere, later in the evening, as the earth continues to revolve upon its axis, and in course of the season many more additional can be counted that appear later as they swing around the circle. There are some stars in the southern hemisphere, however, that never appear to our view, and are only seen except the observer journeys to that hemisphere.

There can be no centre of the universe, for there can be no limit, or a boundary, beyond which there is no universe. Imagine such a condition of things, a centre, which necessarily must include a limit, a boundary on the outside. What must be the nature of this boundary, a shell is it? a crust similar to the covering of our own earth? If it is a boundary, or limit, and no universe beyond, there must be some form of matter that contributes to the make up of that boundary; or is it an imaginary boundary, an ideal line, beyond which is empty space with no form of matter, stars, comets, meteorites, nebula, ether, existing therein? Is space vacant, or not vacant, any less a part and parcel of the universe? Take for example the space between the outer limits of our Solar System and the nearest fixed star, a so-called empty space, occupying billions and billions of miles, is not that space a part of the universe though apparently empty? And is not the space beyond the imaginary boundary of the universe—

if there is an end or limit to it—part and parcel of the universe, though apparently vacant, just as much as the empty interstellar spaces seen within the visible universe?

Centuries ago it was thought by some astronomers, there was a centre of the universe, and that Alcyone, a bright star in Pleiades, must be the centre, around which all of the systems of stars in the universe revolved, as the planets in our Solar System revolve around our central mass, the sun, but long ago that erratic notion was dispelled, and no longer has any hold on the mind of any rational thinker.

It is no wonder that the uneducated on viewing the heavens on a clear, cloudless night, watches hour after hour the constellations revolve around Polaris, the polar star, and thinks it is absolutely the centre. Those farthest off from Polaris are not as easily recognized in their apparent revolution, but the constellations nearer, such as Ursa Major, (the big dipper), Ursa Minor, Cepheus, the Dragon, Cassiopeia, and others, revolving around it, are quite easily detected, but one must dispossess himself of the notion that it is the centre of the universe, for it is not. The North star, Polaris, is not exactly on the pole of the starry heavens, it is about one and one half degrees from it, and it is not fixed or stationary; it has not always been the pole star, and will not be

in the future, for it is estimated by some astronomers that Vega, a bright star in the constellation of Lyra, will be the Polar star in about 12,000 years. Vega is quite an apparent distance from the Polar star at present. Not only was it thought that Alcyone, in Pleiades, was the centre of the universe, but it was also thought by some that the throne of God on which he sat was located there. There may not be many now, if any, who actually believe in this absurd supposition, but I have no doubt the larger half of the people on this planet believe to-day that God is mounted somewhere on a throne, governing the universe, driving and holding it with as tight a rein as the jockey reins and controls his steed. Not a universal God, but a personal God, with an eye, severely scrutinizing every act in our life. If this is true, what diminutive being he must be. A ruler of the universe, seated somewhere on a throne, and governing how large a space? Let us see. Some of the most distant stars observed by our telescopes are so distant that it would take one hundred thousand years for the light to reach us, were it to commence anew, and what does this mean? It means that light traveling at the rate of one hundred and eight-one thousand miles per second will give a distance in miles from us to that star, entirely beyond our conception. Figures fail to enumerate it, and yet that

is but a drop in the bucket, as that is only as far as our telescopic vision reaches; and were it possible for our finite beings to reach that spot, we should see stars just as far beyond as those we left behind, and so on *ad infinitum*. Think of a God seated upon a throne superintending personally the universe. It seems to me blasphemous to belittle God in such an outrageous manner. Where can he be placed, what stars, or systems of stars are big enough for such a being? If it is said there are, how can he be an "all pervading" being. What form shall he be given? It is impossible with our finite minds to conceive of a being, a personal being, without form. Is he in the form of a mountain, a river, as many of the aborigines believed, or has he the form of a man; for this is the highest conception we have of matured form, and man it is said "was made in the image of God." This it may be said is absurd, and so it is, and it is equally absurd to attempt to philosophize upon God. He is certainly beyond our conception, and it is the height of folly for any one to attempt to describe, or explain Him. I believe in a God, a God pervading all space and all nature, but I do not believe in belittling Him, by limiting or localizing Him, for that to my mind is sacrilegious.

CHAPTER XXX.

"THE CREATION."

It is well, perhaps, at the present stage of this work, to consider the first chapter of the book of Genesis, and see what this remarkable record had to do with this "corner" of the universe. If we accept it in its figurative sense, and not literal, as in many parts of the Bible, we shall see as we study the problem, that it is in accordance with the facts in the development of the universe and the planet on which we dwell. The book does not say a day of twenty-four hours, no more than elsewhere where it says, "a day is as a thousand years." Take that in its literal sense, and Jonah would have been in the whale's belly three thousand years, and Christ fasting in the wilderness forty thousand years. These statements must be taken figuratively, as also the days of creation. A day of twenty-four hours does not apply to either case. A day is a period, in some cases it may mean more, and others less. In geological time it means an epoch, an age, and the first day marks the first age or epoch, in the origin and development of the earth.

What does it say about the first day: 1. "In

the beginning God created the heavens and the earth. 2. And the earth was waste, and void; and the darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters. 3. And God said, Let there be light: and there was light. 4. And God saw the light, that it was good: and God divided the light from the darkness. 5. And God called the Light, Day; and the darkness he called Night. And there was evening and there was morning—*One Day.*"

By creation is meant, according to Webster, "The act of constituting, or investing, with a new character—formation." That is just what did take place in the earth's *formation,* it was "*invested* with a *new* character." Nearly all astronomers and geologists are agreed that the earth at the beginning of its formation was a part and parcel of one great nebula mass, which comprised the entire Solar System, extending billions of miles; and the earth in its separate existence "was waste and void," all absorbed, swallowed in the nebula mass, and "darkness was upon the deep." The earth separated from this nebula mass according to the Laplace hypothesis, in a ring, leaving a space between it and the central mass of millions of miles. When the earth was absorbed in the united nebula mass, there was no light upon itself, any more than there is

light within any boiling mass to itself, but as soon as it separated from the central mass, millions of miles therefrom, light began; light shone upon it, and God said, "Let there be light, and there was light." You go to view a mountain summit, you observe it miles away, but no light proceeds therefrom; travel to the moon, two hundred and thirty-nine thousand miles distant, and view that mountain upon the earth, and you will see a bright spot where the mountain is located, it is light; the same as is apparent to us in viewing the mountains on the moon. This is the first day, or the first epoch or age, in the earth's existence as a separate, individual body.

Let us see what the second day brought forth. The good book says: 6. "And God said, Let there be a firmament in the midst of the waters, and let it divide the waters from the waters. 7. And God made the firmament, and divided the waters which were under the firmament from the waters which were above the firmament, and it was so. 8. And God called the firmament Heaven. And there was evening and there was morning—a *Second Day.*"

The first day, we must remember, the earth simply separated from the central mass, the sun, in the form of a ring all around the mass. In process of time when this ring sufficiently condensed, it broke, and separated into fragments,

and through the law of gravitation they all were drawn together, into one huge ball or globe, and in process of time, the earth threw off a ring which was the beginning of our moon; hence when the sacred book says, "God made the firmament, and divided the waters which were under the firmament from the waters which were above the firmament, and it was so." Such a movement actually took place. The waters divided: those belonging to the earth remained with the earth, (three quarters of our planet is composed of water), and the waters of the moon, when that separated from the earth, went with the moon. The space between us and the moon was the firmament, and "the waters which were under the firmament," belonged to the earth; and "the waters which were above the firmament," belonged to the moon; probably at that time in the state of hot vapor. It is probable that the moon was blessed with water in its early development, if it is not now, and hence it becomes plain how "the waters were divided." This is the second day, or epoch.

Here we will pass to the Fourth Day, instead of the Third, for undoubtedly a slight error was made in the order of recording it; for in the nature of things, the grass and fruit trees could not spring forth and grow, and the trees bear fruit, without the aid of the sun. That is to say,

the sun must make its appearance before the grass and trees; and by substituting the fourth day for the third, the order of creation comes along in natural precision; hence we will call this the Third Day, beginning with the fourteenth verse. "And God said, Let there be lights in the firmament of the heaven to divide the day from the night; and let them be for signs, and for seasons, and for days and years. 15. And let them be for lights in the firmament of the heaven to give light upon the earth, and it was so. And God made the two great lights; the greater light to rule the day, and the lesser light to rule the night; he made the stars also. 17. And God set them in the firmament of the heaven to give light upon the earth. 18. And to rule over the day and over the night, and to divide the light from the darkness: and God saw it was good. 19. And there was evening, and there was morning—a *Fourth Day*"—or as mentioned above, we will call it the "Third Day." We must not forget that in the second day the moon separated from the earth in the form of a ring, which obstructed largely the view of the sun and stars, but in the process of time the ring broke and separated; and as in the case of the earth, when its ring broke, the fragments by the law of gravitation were drawn towards each other and formed a ball, or globe, which we see now as the moon, only very much

larger than at present, before it condensed. Then as the Book says, "Let there be lights in the firmament . . . to give light upon the earth," etc. When the moon's ring broke into fragments, and collected into a ball, what a revelation there must have been; the entire starry heavens came to view, and the central mass, the sun, presented itself clearer and more resplendent in all its gradeur, then the moon, just born, gave its reflected light for the first time to the earth. The stars gave "us signs," as in the zodiac, and the sun gave "us seasons, and days, and years." "The greater light, (the sun), to rule the day, and the lesser light, (the moon), to rule the night." This is the *Third Day or Age.*

Now returning to what Genesis calls the third day—which in the present instance we have called the fourth day in natural order, the Book says: 9. "And God said, Let the water under the heaven be gathered together unto one place, and let the dry land appear, and it was so. 10. And God called the dry land earth; and the gathering together of the waters called he seas: and God saw that it was good." 11. And God said, Let the earth put forth grass, herb yielding seed, and fruit tree bearing fruit after its kind, wherein is the seed thereof upon the earth: and it was so. 12. And the earth brought forth grass, herb yielding seed after its kind, and tree bearing fruit,

wherein is the seed thereof, after its kind: and God saw that it was good. 13. And there was evening, and there was morning, a third day"—which in natural order as mentioned, we call the *"Fourth Day."*

The first dry land that appeared, was elevated above the waters near Hudson's Bay, the next that appeared was a portion of the Green Mountains; after this came the Alleghanies, and then other branches of Appalachian system. The Sierra Nevada soon made its appearance above the waters of the universal ocean, following very soon arose the Wahsatch and Cascade range, then was lifted to its present height the Rocky Mountains. These uplifts, and other mountain chains throughout the world, gave birth to our continents. The land appeared first in the western hemisphere; and made greater progress in its uplifting movements because of the forces inherent in the Pacific and Atlantic waters. The immense pressure brought to bear in opposite directions forced the elevation of these mountain, continental areas more and earlier here than elsewhere. The greatest elevations we find running near the Pacific slope, because of the nearness to the deepest waters, and the lesser elevations running near the Atlantic slope because of lesser depths in the Atlantic waters. The gradual uplifting of the continental area in the interior between these coast elevations came in their turn later.

After the land made its appearance above the level of the sea, and sufficient soil was made by erosion from water action and wind, vegetation appeared. Lichens, ferns, mosses, and various cryptogamic plants, followed by grasses and trees in greater luxuriance than is observed to-day; forests of trees of mammoth size, which laid the foundation of our extensive coal areas. And this we will call the close of the "*Fourth Day,*" or Age, in the order of creation.

20. "And God said, Let the waters bring forth abundantly the moving creature that had life, and let the fowl fly above the earth in the open firmament of heaven. 21. And God created the great sea monsters, and every living creature that moveth, which the waters brought forth abundantly, after their kinds, and every winged fowl after its kind; and God saw that it was good. And God blessed them saying, Be fruitful and multiply, and fill the waters in the seas, and let fowl multiply in the earth. And there was evening and morning—a *Fifth Day.*"

The "moving creatures," in the waters had now made their appearance. They were all invertebrates, possessing no back bone. They were classed with the kingdoms of radiates, mollusks, and articulates. One of the earliest among them was the trilobite, a crab-like specie, similar to the horse shoe crab found upon our shores

to-day. The fossils, or rather the imprints of these early animals, are found in Braintree, Mass., among the shales and slates, where I have detected them with considerable clearness. Brachipods, a shelled animal, was also abundant in this period. The first vertebrates that appeared, developed in the Upper Silurian Age, one of the early ages. They were fishes, and in appearance, like the shark species. Later appeared higher up in the animal scale the ichthyosaurs, a species midway between the fish and reptile. And here comes the beginning of the "great sea monsters," the good Book mentions above. Some of them were thirty feet long. They made their appearance in the Mesozoic or Reptilian Age. Their heads were reptilian, similar to the alligators, while their body was like a fish. Another animal was the plesiosaurus, an animal inhabiting the water, with a head like a snake, and neck long and slender; its body like a fish, and its length about thirty feet. The first geological record of animals flying in the air is the pterodactyl, a flying reptile; it had wings like a bat, a membrane attached to both the fore-arm and the leg, a stretch of wing about ten feet. Its head like a crocodile, and teeth similar, with body something akin to a quadruped. No feathers. Birds are mentioned in the holy book as following sea animals, and such did geologically appear. The

birds at this early period, some of them, are the same species as exist to-day; pheasants, vultures, woodpeckers, owls, waders and pelicans, and these "fowl flew above the earth in the open firmament of heaven." And this is the *Fifth Day* or Epoch.

24. "And God said, Let the earth bring forth the living creature after its kind. Cattle and creeping things, and beast of the earth after its kind, and it was so. 25. And God made the beast of the earth after its kind, and the cattle after their kind, and everything that creepeth upon the ground after its kind, and God saw that it was good. 26. And God said, Let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the fowl of the air, and cattle, and over all the earth . . . and this is the *Sixth Day.*"

Geologically this epoch, the sixth, came to pass just as the good Book records it. Snakes made their appearance, and in the same age, beasts and cattle appeared, corresponding, as did the animals mentioned in previous ages, in exact order recorded in the account of creation. One of the earliest quadrupeds appearing was the Tapirus, known as the Tapir. They have become nearly extinct, and possess something the form of a pig, with taller legs and longer snout, and about the size of a small horse. The rodents, her-

bivores, carnivores and monkeys developed in this age; and the early beasts, the earliest of them, mammoth in size, such as the megatherium, the gigantic sloth, the mastodon, the dinotherium, the Irish elk, etc., long ago extinct. Then man appeared, first the primitive man, the pre-historic man, the cave-dweller, and the lake dweller, the mound builder, the aborigines, and then civilized man. And this is the "*Sixth Day*" in the order of creation.

Man is the last and crowning point of creation. Let us consider man, the greatest of all, his origin and development.

CHAPTER XXXI.

DEVELOPMENT OF MAN.

[ED.—This chapter is a revision of a small work I published some twenty-seven years ago, entitled, "The Beginning and End of Man." The edition was exhausted some years ago, and has never been reprinted.—L. S. R.]

The origin of man and his destiny is constantly agitating the brain of mortals, and to many this enquiry is simply nonsense. The child cares nothing for his great grandfather's ancestry, and whether the race dates back a million or two thousand years it matters not to him, since his amusements are not disturbed. The cow eats grass and chews her cud, unmindful of the past, and indifferent about the future. Plenty to eat and drink, and plenty of sleep, is the sum of its requirements, and the apparent completion of her happiness. Montaigne says of Pyrrho, the philosopher, that "being one day in a boat, in a very great tempest, he showed to those he saw the most affrighted about him and encouraged them by the example of a hog that was there, nothing at all concerned at the storm. Shall we, then, dare to say that this advantage of reason, of

which we so much boast, and upon the account of which we think ourselves masters and emperors over all other creatures, was given us for a torment?

To what end serves the knowledge of things if it renders us more unmanly; if with it we lose the tranquility and repose we should enjoy without it, and if it puts us into a worse condition than Pyrrho's hog?" And yet, with all the contentment and undisturbed happiness of this dirty creature, who of us would care to be a hog or a cow, instead of men and women endowed with reason and a full-grown intellect? If "ignorance is bliss," and it is "folly to be wise," mind is a burden and reason a false creation; but as God, or the universe, makes no mistakes, the child is ever puzzling the parent with questions, and is satisfied simply until a new one suggests itself. Nor do these inquiries cease at manhood or womanhood. The happiness of the cow or pig must be very moderate, confined to one faculty, while with man, just in proportion to the development of his intellect his faculties increase, his happiness becomes more intense, and his miseries in the same ratio. "The kingdom of heaven is within," and it is for us alone to make our own heaven or hell. When the inquiries of man cease, his mind becomes dwarfed, and his existence here valueless. Our inquiries must be

for something more than that which we already know, if the answer lies beyond actual demonstration or proof, reason from analogy.

During the early pre-historic age of man it was sufficient for him to know his birthplace, and that he was born of woman; farther than that the past excited no curiosity or inquiry. Time rolled on, and after the lapse of ages his intellect expands, develops; he studies cause and effect, and naturally asks himself, "Whither am I going, and from whence did I or my ancestors come?" The problem he fails to solve. Moses is born a genius; he gains the ears of the people, and they accept him as their oracle. He gives the story of the creation and places Adam at the head of the race. This answered the question of their origin, and their minds were not further troubled. This story was recorded, and became a part of our history. Ages passed, and Moses's record was unquestioned. At last some daring fellow inquires, "If Adam and Eve were the first, where did the woman in the land of Nod come from, whom Cain, their son, sought, and with whom he became joined in matrimony?" This was unanswerable, like the story of the negro who asked his companion, "How Adam was made, if he was the first man?" "Why, don't you know?" replied his companion; "God made him out of clay. He took a bit and made his trunk, then a head,

then legs, arms, etc., and stuck them together and put them up against a fence to dry." "Ah!" rejoins the negro, "who made de fence?" For this unexpected question the companion had made no more provision than did Moses for the question of the ancestry of Cain's wife.

As civilization advanced, the thinker looks about, and through the searching, investigating mind of the geologist and anthropologist finds that six thousand years is but a drop in the bucket compared to the actual existence of man upon this planet. If the record or story of Moses is the oldest written history extant, our progenitors in the pre-historic age left a record more durable and truthful of their existence carved upon the bones of animals known to have flourished in that age. Enter the forest; we pass a bird's nest forsaken by its inhabitant; no bird is seen, but that the nest was the work of the feathered tribe there is no question. We stumble over an ant's nest, run our toes into a squirrel hole, or face a hornet's nest all forsaken, not an occupant seen; yet these furnish sufficient evidence of their former presence, for by their works we know them.

Prof. Niles tells the story of a couple of adventurers attempting some years ago the ascent of one of the mountains of Sierra Neveda. They were cautioned by the natives not to make the attempt, as no man had ever succeeded in reaching

the summit. This encouraged them, and taking a United States flag, up they journeyed, and through their daring and persisting efforts gained the summit; the flag unfurled they waved it to the breeze; and while congratulating themselves as the first men who reached this mountain-top, one of them perchance, looked behind, and, behold! to their great surprise there lay upon the rock a New Testament, a pack of cards, and a rum-bottle! Their glory was lost, for these furnished unquestionable evidence of the presence of man here before. Visit other grounds, make excavations, observe; a piece of quartz attracts your notice, it possesses shape, and looks like an instrument shaped by man—it is an arrow-head; dig deeper and you find another arrow-head made of flint, and by its side a stone hatchet; these discoveries furnish sufficient evidence of the existence of man at the time of these earth deposits containing said implements, and if the geologist, through his investigation is able to inform us the comparative age of this strata containing these deposits, the antiquity of man in that region can, in a measure, be ascertained. That these implements are identical with man there is not much question; for though a monkey exhibits a fair amount of reason when, to crack a nut, he takes up into a tree a stone and lets it fall thereon, and some birds the same when, to crack the shell of a

shell-fish, carry it high up in the air, and lets it fall upon the ground and feeds upon the meat; yet no implements are shaped, and none known to be made by any animal aside from man.

In the Valley of the Somme there has been discovered, in the excavations, fossils of the mammoth and woolly rhinoceros, both extinct, the elephant, hyena, tiger, hippopotamus and the cave-bear. Most of them long ago became extinct in Europe. These animals must have roamed over France, nothing less, says Sir Charles Lyell, than 100,000 years ago. If we can discover associated with these fossils found in the deep excavations the remains of the works of man, we shall establish the fact that his existence on this planet must have extended back to that period at least. His remains or bones we fail to find associated with said fossils. In fact it is very rare that they are found anywhere fossilized; instead, however, of finding his remains, his works indicating his presence have been discovered. Arrow-heads, knives made of flint, other stone implements, spear-heads, hatchets, poniards, etc., etc., were found associated with the bones of said extinct animals. Not only were these implements discovered, but also with them bones, with finely executed figures of animals flourishing at the time engraved thereon. At this period man probably dwelt in caves and lived by hunting, like

the wild Indians of to-day. He brought the game into his cave, devoured it, and possessing in that early day the art inherent in man, displayed it at his leisure in cutting upon the bones the figures above described.

We have found that the antiquity of man dates back at least 100,000 years; we look still further and find that at or near Vezeres, stone implements have been found, of various shapes, clearly indicating the presence of man. The geological strata in which these implements were imbedded is known as the Pliocene strata—rocks that are estimated by most geologists to have been deposited at least a million of years ago. 100,000 years is, then, in reality but one tenth of the probable existence of man upon our planet. But suppose our ancestry dates back to the Pliocene epoch, a million of years, is that the beginning of man? Science has been able to trace him no further from the work he has left, and yet, noting the very gradual progress of the race since, it is reasonable to suppose that a great many years—aye, ages—must have elapsed previous to the epoch mentioned, ere it could have arrived at that stage in art to enable the race to manufacture implements of stone with sufficient distinctness to indicate to their posterity, a million of years distant, their presence upon the planet.

The race, in fact, must have dated as far behind

the stone-implement age as it now dates from it—for the progress from the very low man, or the animal plane, to the age of manufacturing and using instruments of stone, must have required as much time to develop it as, since the stone age, to have arrived to our present attainments in the arts and sciences. If, then, we traced the existence of man to the Pliocene epoch, where the stone implements were found, and which is estimated by most geologists at nothing less than a million of years, added to which the number of years prior to said stone age, which we estimated equal to the elapse of time since, makes some two millions of years—the shortest time, from present discoveries, that man could have existed upon the globe. Suppose, then, that two million of years approximates towards the nominal appearance of man as a distinct variety in the animal kingdom, did he appear in the form of only one man, and one woman; and from which first pair our entire race originated or multiplied? or rather did man at this time spring from the earth a distinct species? If he did not proceed from the entire animal kingdom, from the lowest form, the protozean, through the highest, the vertebrate, mammalia, the earth must have sprouted him, for the old obsolete notion, or rather superstition, that God scooped up a bit of dirt, shaped it into the form of man, infused into it a spirit, or in

some fashion created him and set him in motion, as does the engineer his machine or engine, after its construction, is not accepted by any rational thinker.

What are the chances of his proceeding or springing from the soil in the present form, or that of the primeval or pre-historic man? And through what other source could he have possibly proceeded unless through the animal kingdom as before described? If man was always a distinct species, proceeding from nothing below him, could his body have been created, started, or formed, from anything beyond or apart from our planet? Every moving, material form upon the earth is a part and parcel of it; from it all matter, whether in the form of man or a cabbage, originally proceeded; and as it is a self-evident fact that God cannot create something out of nothing, man, if he did not develop from any species below him, but was created a distinct species, his body God must have formed from the earth or soil. Its analysis proves that it originally proceeded from it—for when his body decays there is no chemist on the globe who can detect or separate the constituents of the body from the soil; and yet the instantaneous or immediate creation of man's form from the ground, the most complex being that exists, is monstrously absurd, for what shall be his size? Was he placed upon the earth, or did

he sprout up, a full-grown man, say one hundred and fifty to two hundred pounds? And the stature of the animal kingdom to-day, including man, is certainly no larger than ages ago, but probably smaller. Is it possible for a being of any description of above dimensions to spring into immediate existence to-day? And if not to-day, why a thousand or a million of years ago? Is it possible that man was placed, or was sprouted from the earth a babe of the smallest dimensions? That seems more improbable, for what being throughout the animal kingdom is more helpless than the infant? A year before it can even walk! and, alas! how many years before it could possibly obtain its living!

Can we imagine an instance to-day of a new-born infant robbed of its parents, and surrounded by no human beings thriving and developing into manhood? And, if impossible to-day, why more possible a thousand, or a million, years in the past? The same laws regulating the birth and existence of beings upon the earth were in operation then as now. God's, or nature's laws, are immutable, unchangeable. To be sure it is said of Romulus and Remus, in a legend in ancient times, that they were nursed and nurtured by a wolf; but every rational mind knows it is fiction, for nature has not endowed wild beasts with such unnatural faculties; every species looks to its own

kind. If it cannot be demonstrated through nature's laws that man's body is a distinct creation, what of the species below him? Is it any more probable that the ape was created separately? or the dog or cat? What are the chances of a full-grown ape, dog, or cat, springing into immediate existence? Does nature, through which God only works, suggest even a shadow of such a probability? And is it any more probable that their young, if not gradually developed from the species below them, could possibly live and thrive without that fostering care which a parent alone can give? But as we descend in the scale of animal life, passing through the birds, reptiles, fishes, articulates, (which includes insects, spiders, worms, etc.,) mollusks, or shell animals, and radiates, such as polypes, or coral-builders, jelly-fishes, star-fishes, etc., etc., to some of the lowest forms of animal life such as the sponges, etc., the nearer the approach to these lowest forms the more spontaneous their reproduction, and the less dependent are they upon the parent for support.

If a dog has always been a dog; a cat, a cat; an ape, an ape, and a man, a man—each a distinct creation—it is implied that each was created from something. Where were they created? In the skies? Where in that lofty region was the material obtained to form a body of any

shape? If not created above the earth, and if created at all a separate species, it must have been formed upon and from the earth; and whether its form was the smallest or the youngest of its kind, or whether it appeared a full-grown dog, cat, ape or man, it matters not, for nature possesses no laws whereby it can produce any form of life without a parent. God's laws are natural and immutable; no law was ever changed, nor ever can be, whereby a quart of water can be put into a pint-bottle. Statements come to us from ancient books of change in laws to display a supernatural power, but sufficient proof of the truth of such statements is not given. As the intelligence and independence of the age advances, faith is established through the most searching investigation of the laws that develop and govern every atom in the universe; faith in their immutability, which only allows change in forms of matter; but change in the laws that control them, either in the most remote past, or the dim future, never. If, then, we have begun to understand the immutability of every law, the veriest dunce cannot fail to perceive that the law which would not allow an unnatural production or creation to-day could not have allowed it thousands or millions of years in the past—or, in other words, a law that cannot be altered or amended to favor a certain production or creation to-day could not have

been changed thousands or millions of years ago.

No one can reasonably pretend for a moment that a law exists to-day whereby man can be produced or created from the earth a full-grown man from one hundred to a hundred and fifty pounds, or in the form of a helpless infant with no possible means of sustaining life for years after its birth. As to the "first man," its parent must have been the highest order of animal life then existing; not necessarily an ape or a monkey, but possibly and very probably a higher developed species, now extinct, exterminated by the pre-historic man, the latter far below the most inferior savage now in existence; hence the parent of the "first man," the highest order of life then existing, was but a step below, the development being hardly perceptible; like the child of to-day, through the combined organism of its father and mother it inherits at times superior qualities, which places it ahead of the parent stock, and transmitting them to its progeny, its descendants obtain the start in the race of intellectual or superior life.

The gap between man and the next order of animal life at present—say the ape—is very wide; but the gap will continue to widen, so that ages in the future, the gap in the present era, if the facts could then be known, will seem very narrow compared to the very wide gap which must

necessarily exist in that distant epoch; and why?

Glance at the animal life of America. Not many years since, (but a few hundred), the wild beasts roamed from the cold regions to the equator; America teemed with them; where are they to-day? The march of civilization has driven them back; one species after another of the highest order of beasts have been exterminated, so that to-day, where man or civilization extends, nothing remains of the wild beasts to indicate the homes they once enjoyed, but their bones, and these, through the aptness of the Yankee, are rapidly being gathered and converted into manufacturing and agricultural purposes—as, for instance, in the northern portion of America, where immense quantities of the bones of the elephant are dug up, also remains of other animals in the bone-beds of Carolina, all being utilized, and their original form destroyed, so that in the future not even the bones of beasts will remain to mark the pre-existence of the higher orders of animal life, except here-and-there a relic stored away in a museum; the gap widens, other "links-missing." What is true of the extermination of wild beasts in America, as rapidly as man advances, is becoming true in other and all parts of the globe.

What of the lower races of men? is not the gap widenning constantly here? The living link between civilization and the pre-historic man is

fast becoming "the missing link" by the extermination or extinction of the aborigines. Take North America, the native home of the poor Indian; from the lakes to the gulf, from the Atlantic to the Pacific, his reservations extended; the European advances; he plants himself in their homes; the Indian is doomed; the work of extermination begins; a few only remain to remind us of the original extensive tribes; back, back they have been driven to the furthest extent of our realm, and the only home that now awaits this small remnant of the aborigines of America is the watery deep of the Pacific. The Australian savage, the native of Australia, is being also rapidly exterminated; but few remain to indicate the existence of this very low race of men. They are the lowest living on the face of the earth. They can scarcely count four, and after their entire extermination, future ages will scarce be able to conceive of the existence of these low savages, and unless their bones are carefully preserved, and a record of their race kept, this link will be missing; the gap between the lowest man and the next highest order of animals will be wider. The natives of New Zealand, the cannibals, are also being rapidly exterminated. A few years more and nothing but their bones or records, if preserved, will indicate the former existence of these wild savages upon our planet. If

all is lost, another link is missing; and in early pre-historic times there were no printed records, nor any bones preserved; for petrified or fossilized human bones, as before mentioned, are extremely rare. Hence the highest orders of beasts being rapidly exterminated in all countries by the advancing tide of civilization, and the equally rapid extermination of the lowest races of men on the globe, will, in the course of 100,000 years distant, vastly widen the gap, and the "missing link" in that age will prove a far greater puzzle.

We have found that the link connecting the lowest man and the next order of animals does not exist, and that its existence is not at present a necessity, since man has reached his present development, for the gap, we learned, has widened, and is continuing to widen, so that in the distant future the hour must come when every wild beast upon the face of the globe will be exterminated, and with equal certainty every savage tribe and all the lower orders or races of men must pass away and become extinct. The gap will then become so wide between the bimana and quadrumana that unless their remains and records are preserved it will be impossible to form a conception of the pre-existence of these extinct forms. Hence it is fair to presume that further advanced types of quadrumana, that were nearer allied to man than now exists, will become extinct and buried in the vast accumulations of ages.

Paleontology is in its infancy, for the times are comparatively recent since the discovery and classification of fossil remains. Is it not equally probable that types or races of men much lower than any of which we have record, and more closely allied to the quadrumana and quadrupeds may have existed in the Miocene, and possibly in the Eocene, age? No rational thinker believes that all forms of animal life were created at the same time; for every geologist is aware that many forms became extinct ages before the appearance of mammals upon the earth; as, for instance, nine species of Trilobites became extinct at the close of the Primordial, or the earliest geological age; eight species at the close of the Lower Silurian; five at the close of the Upper Silurian; and all became extinct before the close of the Carboniferous, which was many million of years prior to the age of mammals, which includes all animals that suckle their young. What is true of the Trilobites is true of many genera, and thousands of species apearing in one age became extinct before the close of the following age.

The perpetuation of the species is in progress; but entirely new forms, newly created, and not proceeding from lower and older forms, are wholly improbable if not impossible, for if thus created what are they created from? Should it be announced that some new genera or species

had developed in the air, or sprouted from the earth, it would be pronounced a joke, and the hesitancy in visiting the curiosity would be as great as is exhibited on the first of April when a white elephant is announced to appear upon the Boston Common. Spontaneous generation, I know, is regarded by some as probable, but the fallacy of this notion is nowhere more apparent than during the inspection of canned fruit. The theorist takes a liquid or solid, submits it to an intense heat, double or treble boiling heat, so high, in fact, that the existence of life is impossible in the mass (not making it certain, however, that infinitesimal living forms outside may not in some possible way drift in when cool and develop), while the canner of fruit brings the mass simply to a boiling point, hermetically seals the vessel containing it, places it on the shelf, where, as in many cases, it remains for several years, and when opened no signs of animal life is manifest; hence the theory of spontaneous generation is not accepted.

Evolution, or the law of progressive development, works slow; time, ages, are its demands, while a thing created, new, independent of any other form, must of necessity be rapidly organized. To develop, then, a new variety by the law of progression takes time. What is two, four or six thousand years compared to a

geological age, the years comprising which are estimated by millions? Pass down the line of ages and mark the gradual development from the lowest form of life, in the earliest geological age to the present, culminating in man, and then let the question be put, If man is a separate creation, and not a gradual development from the lower to the higher, why was he created in the present and latest age? why did he not appear in the earliest epochs—the carboniferous, for example, the age of plants? The answer is simply that he had not developed. Fishes at this age were as high in the scale of animal life as the earth was able to develop; it required several ages, or many millions of years more, through the many steps of progressive development, ere so complex and perfect a being as man could be developed.

Commencing with the Root-footed animals, among the earliest, we find life in the most simple form—a mass of flesh heaped together, assuming any shape it chooses, from a rounded mass to an oblong, then elongating itself into an eel-like figure, with no fixed stomach, but located in any part of the body that might temporarily suit the creature; with mouths as changeable, as also its waste passage. An animal with less system in its organism cannot be easily imagined. Yet there is the Protozoa, the sponge, which is simply a pulpy, living animal mass with no organism

whatever. Pass to the Polype, the coral-builder, and we find its organism a little more systematized; its stomach is a small inner sac suspended loosely from the mouth, which is fixed around the latter; there are a large number of tentacles, or feelers, which the creature throws out in search of food. They reproduce by eggs which are dropped in the sea, and finally lodge upon some rock, where they hatch, develop and become fixed thereon. They also reproduce by branching out, the same as the limb of a tree branches from the trunk. Pass on to the Echinoderms, and the sea Urchins, they are farther developed by the addition of a heart, a stomach and a mouth. The Mollusk, a soft-bodied creature, including all shelled animals, flourished largely in the Silurian age, called by some the age of Mollusks.

In this very early epoch the Brachiopod was quite predominant, its development a little in advance of the animals heretofore described; it is not fixed to a rock, but is free to move at its pleasure, and is assisted largely by two fleshy arms which it can protrude or withdraw at its will. Mollusks generally possess none of the organs of sense except eyes, and some species are without them. Up to this time insects or fishes were not developed. Crustaceans and Annelids, or worms, began to appear, and the organism of the latter, higher and more complex. The body

is divided into several segments, which enables it to twist about, and is covered to some extent with bristle-like appendages which assist its powers of locomotion. They possess a system of veins and arteries, the blood of which is red. Each worm is both male and female in one, or bisexual.

At the commencement of the next age, the Devonian, insects appeared, presenting a higher degree of development; their bodies being divided into three distinct parts, the head, the thorax, and abdomen, and their powers of locomotion greatly promoted by the possession of six legs, and two or four wings. During this age, fishes made their first appearance, and hence this epoch is often called the Age of Fishes. Up to this period no vertebrates (animals possessing a backbone) were in existence, and when fishes appeared the development of a backbone was a marked feature in the progress of the kingdom, for all animal life is divided into two classes, vertebrates and invertebrates. The development from an invertebrate into a vertebrate was gradual, for there existed a species called the "Ambeogisis," which possessed evidences in its organism of passing through the transition state. The earliest fishes, it is thought, belonged to the invertebrates, and not for many years was there developed in them a backbone. The gills

of these creatures in the Devonian period were undeveloped; there were holes at the sides with no covering.

In passing upward through the line of ages the wonderful development in the fish species is marked, and as we pass the Carboniferous age some of these creatures begin to assume a new form, the pectoral, or small cartilageous arms, terminating into a hand, with slender fingers (which is a gradual but great advance from lower animal forms), developed at the close of the Carboniferous, or at the opening of the Secondary age, into stouter and more bony arms, while the limbs, corresponding to the ventral fins, terminating with a foot, with slender toes, developed equally in strength and size; so that the fish became possessed of large, stout, bony legs and feet, with its caudal appendage strengthened and passing into the reptilian form. This age is called by modern geologists the Age of Reptiles, reptiles being the predominant animal in that epoch. The connecting link is nowhere better shown than in the Ichthyosaurus, a Greek term meaning fish and reptile, or lizard. This is an extinct animal, probably developed in the Carboniferous age, and becoming abundant in the Secondary. Its head was of a huge reptile, large, elongated mouth and teeth, but possessing fins to paddle its way along. Its vertebræ deeply concave, similar to the fishes.

Another link connecting the reptile with the bird is found in the fossil remains of a Pterodactyl, a flying reptile existing in the Secondary age. Its head is the form of a reptile. Its legs support a membraneous wing to enable it to fly. Although a reptile in structure, possessing no feathers, yet like birds, their bones were hollow and were adapted for flying, by the possession of enormous wings. In the quarries of Solenhofen there has been found fossil remains of birds that possessed some characteristics of a reptile; but, while some parts of its organism was reptilian, it was, nevertheless, a bird possessing an expanse of wing and feathered. The connecting link between the bird and mammals, or semi-mammals, is found in the fossil remains of a bird-like kangaroo, its head the structure of a bird, while its posterior portion is constructed like a kangaroo. The connecting link between mammals and man has been enlarged upon quite sufficiently heretofore.

In the Tertiary (the most recent geological age, following the Secondary above mentioned and called by many the Age of Mammals) roamed the *hairy* elephant and wooly rhinoceros. The temperature of that period was undoubtedly much colder than the present age, consequently those animals required a hairy and wooly covering to protect their mammoth bodies from the

extreme cold; but, as the temperature gradually increased to its present average height, these coverings were useless and dispensed with, as the naked presence of these beasts to-day testify. Take, for instance, the pig, which possesses a structure akin to the alligator. In developing to the higher the latter generally lost its stout and bony caudal appendage, having, in roaming the land, no further use for it, and also its huge mouth and teeth, which suited its half-aquatic habits. So with the ape family, the general structure of which so nearly corresponds to man, requires long arms and hands, and also feet, hand-shaped, to enable it more easily to climb trees for self-protection in the forests, gather nuts and fruits, which form their chief subsistence; but as man developed, he procured his living by his wits, hand-like feet and long arms for climbing and locomotion "on all fours" were useless, and in assuming the upright position his feet flattened out, the disuse of the arms and hands in walking upon them, caused both hand and arm in time to shorten or become smaller, the same as the blacksmith can by use or disuse cause both to strengthen or weaken. So with his canine teeth; the earliest pre-historic man, who lived most entirely by hunting and fishing, undoubtedly possessed long canine teeth like the ape, to enable him to tear flesh and tough substances

more easily; but as man developed into a more civilized being he tilled the soil and subsisted more upon vegetable food, and the disuse of the canine teeth for tearing flesh shortened them, so that to-day they are found comparatively small.

We have thus traced man from the lowest form of animal life; from the earliest geological age to the present; and the gradual development from the lower to the higher, hastily, yet carefully sketched; and yet do we find the beginning of man? not yet. From what did the lowest animal develop? Whence its origin? Is it possible that the animal kingdom sprang originally from plant life? Huxley tells us that yeast is made up of a mass of minute living plants called the yeast-plant, or, scientifically termed, Torula, belonging to the fungi group. Fabroni discovered that this plant was the shape of a bag, that the outer portion contained the properties of wood, while the inner portion of the bag contained the properties of animals, among them "Protein," the foundation of every animal organism; he consequently called it a vegeto-animal substance. It was also discovered that this inner matter possessed the power of contraction, similar to that of the substance of animals. This substance, which is found in the interior of vegetable cells as well as in all animal substances, was

named by Hugo Von Mohl, an eminent German botanist, "Protoplasm;" and to-day the fact is largely conceded that the animal kingdom—which of course includes man—proceeded from this shapeless vegeto-animal mass. This, then, we will call the bridge over which the vegetable kingdom passed or developed into the animal.

Corals were so akin to plant life that many years elapsed ere the discovery was made that these apparently low branching trees, decked with beauteous colors and fixed to the ocean's bed, was the product of animal life, and the Polype producing them had some peculiarities of a plant. They propogate largely by branching out from the side of the parent stock, the same as a limb or branch from the trunk of a tree, so that a community of them have the appearance of a tree with branches thereon. They are usually fixed to a support, the same as a plant, but they are animals containing simply an inner sac for the stomach and mouth; around the latter are arranged rows of tentacles, like the petals of an aster—says Dana—about its central disk. Turn these animals inside out, which has been performed, and they live and thrive; cut them to pieces and they propagate.

The Crinoids, an extinct animal flourishing in the Paleozoic and Mesozoic time, was a creature possessing a very close resemblance to a plant.

Its trunk, tree form, was firmly attached to a rock, and its long sweeping tentacles presented the appearance of thickly-waving branches of a plant. The sponges, until a comparatively recent time, were considered of vegetable origin, and possessing all the appearance of plant life, but modern scientific researches have revealed the fact that they belong to a group of the lowest form of animals, called Protozoans; thus, these vegeto-animals, resembling species enumerated above, may be justly termed the apparent connecting links between the vegetable and animal world.

We found it possible that man not only proceeded from the very lowest forms of animal life, but that, in all his grandeur, he is a direct descendant of the vegetable kingdom, the tree, the shrub, the Cryptogam.

The development of man from plants, through the lowest forms of animal life has been gradually, yet hastily traced; but his origin beyond which no trace of development is possible, has not yet been found, for plants cannot be a special creation any more than man can be specially created. All plants germinate; that is, the seed from which they spring contains the plant, root, trunk, branches, all in a miniature form, and when sufficient heat and oxygen reaches the buried seed the miniature plant unfolds itself, ex-

pands, and grows into a shrub or tree, according to the strength or force of the species to which the plant belongs. Plants owe their existence to the ovary and ovule, and unless they are impregnated through the pistils by the pollen from the stamens of the male or staminate plant, whether upon or apart from the same stock, they cannot exist (Cryptogams excepted). The analysis of plants denotes their earth origin. Pass down the line of ages to the early development of our planet, when the globe was entirely covered with water, and plants with no possible chance of existence—for soil was not then formed, and the ocean's bed was one vast solid. At last the spell is broken; an elevation through eruption, or a more gradual force, sends a portion of the rocky bed above the universal ocean; bed after bed, scattered through the mass, is elevated; and with rocks exposed to wind and rain, erosion takes place, the rocks disintegrate, and soil, or pulverized rock, the consequence.

Now, to say that rocks or soil contains life is radical, but, nevertheless, I launch the assertion. We say a thing has life that possesses the power to grow and develop. Rocks do not apparently possess that power, and yet when we study their structure carefully and thoughtfully we find that changes in their forms have been constantly occurring. Look at the pure crystal;

has that not passed through a process of development, from the simplest amorphous rock to the highest crystallization? We say this is due to some chemical action, largely through heat; but what is heat? It is simply the manifestation of a force; not that heat is the force itself, any more than the power of speech is the force that works the brain and moulds expression. Speech is simply the manifestation of that force which is behind both speech and brain, and unseen. So an unseen force is behind heat, the latter being simply the phenomenon, and not the power that prompts or propels it. Heat I do not regard as a link in the "correlation of *forces;*" but a link in the primary *manifestations* of force, correlated to each other, as light, motion, electricity, magnetism, etc. These are all resolved or reduced to one primary force, which produces said primary correllative manifestations.

Spend an evening with Tyndall, as I have done, and watch his experiments in crystallization. As soon as the current (from a voltaic battery) began to pass, one wire became covered with bubbles, while from the other, foliage grew with the most extraordinary rapidity. The particles seemed to form in the liquid, to come into existence and rush with violence to attach themselves in leaves and frond-like forms to the attractive wire. The secrets of nature were

shown to us, like witnessing creation. The general appearance of the "tree" was fern-like and graceful. Tyndall says: "In the process of crystallization nature first reveals herself as a builder. Where do her operations stop? Does she continue by the play of the same forces to form the vegetable, and afterward the animal? Whatever the answer to these questions may be, trust me that the notions of the coming generations regarding this mysterious thing which some have called 'brute matter' will be very different from those of the generations past." Life in each kingdom is differently developed. In the animal kingdom growth of stature ceases at a certain age, while in the vegetable kingdom it continues through the individual existence of the plant. The former possesses the power to move from place to place at will, the latter is fixed to one spot, and derives its nourishment chiefly through the lower parts of its organism, while the sustenance of the animal kingdom is taken through the upper. The resulting processes of these developments are easily explained, save the first, in the cessation of growth of man or animals at a certain age; and why said physical growth does not continue through life, as with the plant. is not yet satisfactorily explained. All of the other processes and developments, are simply the results of some

force which propels and gives shape and form to matter, not only in the animal and vegetable kingdoms, but in the mineral kingdom, which manifests itself, though differently, yet most distinctly, in varied crystallizations.

The differentiation in life is very marked in the development of our planet. To-day, in man, more than all others in the broad realms of nature, dwells the greatest and the widest manifestations of life. Like the beast, he enjoys the powers of locomotion, self-defence, etc., but, more than that, he enjoys an intellect, as varied as it is great, and as far beyond the beast as the latter is beyond the oyster, or the oyster beyond the lowest form or manifestation of animal life, the protoplasm. In the first, the most recent planetary development, *man,* we find the broadest variety; in the beast its development is less marked; in the oyster the differentiation in life is reduced to a very narrow limit; in protoplasm, the base, or the lowest round in the ladder of animal life, the variety of manifestation is as small as is possible to imagine in this kingdom. In the vegetable kingdom differentiation is still less marked, for life is manifested only in reproduction and growth with changing forms, while in the mineral kingdom the variety of life's manifestations are reduced, not to its minimum development, but to the lowest or narrowest limit

in matter as a solid; its manifestations though less apparent than in the higher kingdoms, is nevertheless to the investigator positive, for growth and change of form through crystallization is everywhere observed. Vegetation develops largely through the influence of heat; so does crystallization in the mineral kingdom develop largely through the same manifestation of force.

Dr. Carpenter, the English scientist, gives undue influence to the manifestations of heat. This element he considers is the vital force, the very life, that animates our being and all matter; but with like consistency he might claim the same pre-eminence for oxygen, for without the presence of the latter, seed could never germinate, nor the egg develop into life. Another claims that electricity is the basis of life; but, be it heat or electricity that animates the vegetable and animal kingdoms, must we not claim that through both of them the mineral kingdom develops in growth and change of forms through crystallization; but, as previously stated, both heat and electricity are correllated manifestations of a force, not the force itself, that prompts the action; the latter we may call the vital element which animates the universe, giving life to rocks through crystallization, and development to plants and animals through germination. To

produce a good plant we must see that the soil contains those mineral properties which we know the plant upon analysis itself possesses, for the plant is simply a mineral, or minerals reproduced, or developed, or, in other words, metamorphosed into vegetable life.

In primeval times it is probable the same force that develops crystallization—call it life-force—varied its manifestation and produced a germ, simple in its structure, a minute globular bag, a single cell, possibly microscopic. When coming in contact with that quickening element, oxygen, and the sun's heat and light, it expands, a new kingdom is born—the plant. The earliest plants are known to be very small, almost microscopic; a careless observer passes every day rocks apparently stained, or colored, which, upon close inspection, are found to be a low order of vegetation, belonging to the Cryptogams, or flowerless plants. Such were undoubtedly the appearance of the earliest vegetation. Having traced man to the rock, have we found the beginning beyond which there is no trace? Not yet.

What is there that runs through this entire chain of the earth's development? What that caused the nebulæ to condense, especially one portion more than another? What caused the earth to separate in the form of a ring, and then take the form of a globe? What caused it to

possess two motions at once, the rotation upon its axis, and its revolution around the sun? It is the same cause or force that enables man to run or think, the fish to swim, the seed to germinate, the tree to grow, the mineral to crystalize, fluid to solidify, or vapor to liquify; and that force must be the vital or spiritual force, the life that animated not only the earth in its primary conception upon its launch into existence as an individualized entity, unfolding itself in its varied life-manifestations through rocks, water, trees, beasts, man, etc., but the same force, or life, that animates the entire heavens, giving motion, light, heat, gravitation, all, to the vast bodies floating in space, to all matter extending through the length and breadth of the mighty universe; not forgetting that gravitation, electricity, motion, light, heat, etc., through which all nature apparently operates, are but the manifestations of this living, vital, propelling, spiritual force.

An atom is the lowest form, or the smallest division of matter. All atoms of matter, says Papillon, are one and the same thing, but the different energies and forces combining them change their nature; motion alone determines the variety and unity of matter; but motion is as subordinate to force as speech is to thought. The materialist tells us that spirit, or life, is the result

or product of matter; that matter is first, and spirit, or life, follows it. If I am wrong in my assertion that a certain force or energy, call it life or spirit, runs from the primary conception of our planet through its gaseous and liquid state to the mineral, vegetable and animal kingdom, through the differentiation in its many manifestations, culminating in man; if, I repeat, this statement is not practically or theoretically true, then I should have faith in the materialist, for if life or spirit was not made manifest upon our globe until the appearance of plants and animals some millions of years after the earth's formation, the conclusion is obvious that matter was all this time preparing to develop life or spirit, (if spirit is the result or product of matter), which on the face of it is totally absurd—for the very fact of matter developing life or spirit, or if spirit or life is developed from matter in any form, is proof positive that some force acting behind or through matter was necessary to develop said life or spirit; for development cannot take place in any shape unless some force exists to set it in motion, and that force can be nothing less than that life or spirit which pervades the universe.

Then, when the distinguished scientist, Papillon tells us, as before mentioned, that all atoms of matter are one and the same thing, but the different energies and forces combining them

change their nature and variety, we are led to the belief that matter in all its varied forms and conditions is wholly developed through the energies of life or spirit-forces. Having traced the life and composition of man to the great nebulæ, from which our planet was born, or thrown off, is this the beginning, the primal base, or fount from which our lives and bodies evolved or sprang? Most assuredly not. What is the origin of the nebulæ? One class of nebulæ is found through powerful telescopes to consist of an innumerable quantity of stars, which through smaller lenses gave the appearance by their immense distances from us, of a cloudy, hazy mass. Another class to which the nebulæ from which our earth separated belongs, is gaseous, comprising many of the properties that our globe contains to-day. What this nebulæ originated from is still an open question. The universe is more or less filled with cosmical matter, from very small bodies to bodies of immense size, some of which are solid and others gaseous.

In the little space which our own solar system occupies, there are innumerable little bodies called meteors that are solid, and converted into gas when reaching our atmosphere; there are also comets of immense size, as light as gas, whose path is parabolic, passing into space and never returning to our system again. And the

gaseous mass exploded or ejected from the sun to-day, if it travels with the velocity of five hundred miles per second—as is the case in some instances—it passes, says Proctor, beyond the control of the sun tangentically into space. Now, it is possible that these fragmentary, cosmical, gaseous masses collect and form a vast nebulæ, from which worlds are born. Farther back than this it is impossible for man to trace that form of life and matter which composes his being; it passes here into the great unknown; and yet this life and matter is as anterior to the nebulæ in some unexplained form, and as certain as its existence that we have traced since the nebulæ formation; hence the beginning or primal origin of man must remain as undiscovered as the origin of the universe with which it is identical.

Having reached the utmost limit of man's comprehension, let us look very briefly at the general principles upon which evolution or development is founded. What are the facts? If, as Herbert Spencer suggests, the nebulæ hypothesis so generally accepted is correct, what do we find? That the law of matter and all life is to develop from the simple to the complex, from the lower to the higher form.

Take the great nebulæ from which the earth sprang, with no fixed shape, floating through space a simple, homogeneous mass, as far as ap-

pearance indicated. No heterogeneous compilation was then manifest in this gaseous, nebulæ mass. Could a being of our own manner born have ridden upon this floating billow, and been told of the many planets, comets and meteors which this simple and unpretending cloud would give birth, his eyes would have protruded from their sockets, and his brain electrified by this stupendous thought. The homogeniety throughout the mass became eventually disturbed; portions of it began to condense, concentrate, and become heavier. Development has here commenced; the evolution from the simple to the complex is in progress; what was once homogeneous is now becoming heterogeneous; separation from the great nebulæ takes place; Mercury, Venus, Earth, Mars, the Asteroids, Jupiter, Saturn, Uranus and Neptune launch into space; and not only has this nebulæ, cloud-like mass developed these planets, all of which revolve upon their own axis, and also revolve around the central mass, the sun, but some of them have developed smaller planets or satellites, which also perform a revolution around said primary planets; and again the heterogeniety developed by the nebulæ mass is further displayed by comets and meteors, which are as abundant as the fish of the sea.

The vast complexity which these simple, hom-

ogenous, nebulæ, cloud-like mass has evolved, as one dwells upon the grandeur and marvellous variety of the solar system, amazes the wisest of us; and when we come to consider that each one of these planetary bodies has passed, or will pass, through the same development and differentiation as our own earth, evolution from the lower to the higher, from the simple to the complex, seems positive. This is clearly manifested in the progress of our own planet. After our separation from the nebulæ mass the globe continued cooling and condensing until it passed into a liquid state, differentiation developed, heavy metals began to manifest their individuality by solidifying; gold, silver, lead, mercury, copper, etc., have separated, silicon, aluminum, calcium magnesium, sodium, potassium, and many other bases, solidified and patiently waited the fall of the condensing acids, sulphuric, carbonic, chloriodic, chloric, nitric, phosphoric, etc., to unite with them in the formation of rocks in their numerous varieties. The simple, homogeneous, gaseous globe in unfolding itself, became more heterogeneous, and more and more complex. Like an ordinary garden-seed, which appears one simple mass throughout and apparently homogeneous, yet, viewed through a microscope, its future development and heterogenous and complex structure is observed, as the plumule, or

trunk, and radicale, or root, with branches and leaves, all are snugly folded up in the simple covering, and only wait germination to unfold itself, expand, and develop into a plant. So with the chrysalis; it is apparently a lump of matter encased, simple and homogeneous, and to all appearance dead, inanimate; but by the aid of a good lens the future butterfly is discovered through the covering, with its body and wings snugly packed, the antennæ, or feelers, by the side of the legs and tongue between the latter, waiting the unfolding, or development, into the winged-fairy of the air.

In the caterpillar the future butterfly is sometimes seen closely cramped up within, and must pass through two metamorphoses ere its simple, homogeneous mass reaches the complex, heterogeneous form and structure of the butterfly. So with the globe; it had simply to unfold itself and develop from time to time new forms and varieties, with constantly wider differentiations, and become more and more complex and heterogeneous. Observe the wonderful variety into which the vegetable kingdom has branched or divided. Already there have been discovered some three thousand separate species divided into orders, families and genera, to say nothing of the untold species yet undiscovered. One has but to stand upon the threshold of the very interest-

ing science of botany and peep into the herbarium of nature to fully appreciate the beauty in the wonderful variety of plants with which our planet is decked. A further unfolding of the earth is made in the development of the animal kingdom. How wide its differentiation from the sponges to man, from the oyster to the highest type of animal life! Baron Cuvier describes in his great work many hundred species moving over the globe; and when we examine these species, and find each species subdivided again and again into numberless varieties, as in the dog, for example, the mastiff, shepherd, Newfoundland, etc., etc., also the horse with its varieties, our wonderment is increased. But when we again consider that throughout the entire living mass, and all matter, upon the globe, there are no two individuals or objects alike, we are still more amazed at the wonderful advance from the lower to the higher, the simple to the complex, from the nebulæ, homogeneous, gaseous mass of our planet in its infancy, to the almost incomprehensible wide diversity or differentiation in life or matter to-day, culminating in man, the latest and most complex or complicated form in all its aspects, that our planet has yet produced.

In tracing man from the earliest development of the globe we found that some force, call it

life or spirit, behind the correlated manifestations of force, heat, light, motion, electricity, etc., gave the impulse and caused the development of our planet in its varied manifestations, heretofore briefly described. The question now arises whether this life-force or spirit manifested in different bodies is sufficiently individualized to enable it to preserve its identity, as in man, throughout eternity. Or, in other words, if better understood, will Lysander S. Richards live, and his individuality continue forever and ever?

The antecedents or antiquity of man can be traced with some show of certainty through a chain of solid facts, but when we approach the question of the end of man, or his life beyond the grave, the facts presented to us are subjective, or more or less speculative. Yet no one aside from the materialist will, I presume, attempt to deny that the life or spirit principle developing man and all being or things upon our planet continues through all time, without end. But in what form it continues, whether individualized in one person or thing, as upon the earth, an individual entity, a spiritual body dispossessed of matter, or whether it enters or is swallowed up in a universal life or spirit-mass pervading the universe, is the vital question of the hour. Advocates of the latter notion tell us that as a drop

of water falls into the ocean, mingles and is lost in a great liquid mass, its individuality and identity ceasing, so does life or spirit departing from the body pass into the great universal life or spirit mass, and its individuality is forever lost. Let us see if this illustration holds good.

Water is made up of two elements, oxygen and hydrogen, and the smallest particle into which a drop can be divided is a molecule. Picture in the mind the smallest particle of water imaginable, and divided into a million of times, and the particle is not yet reduced to a molecule. Prof. Maxwell in substance says: "The size of a hydrogen molecule is such that if two million would stand in a row they would occupy a millimetre, and a million million million million of them would weigh but four or five grammes. The molecules are conformed to a constant type with a precision which is not to be found in the sensible properties of the bodies which they constitute. In the first place, the mass of each individual molecule and all its other properties are absolutely unalterable. In the second place, the properties of all molecules of the same kind are absolutely identical. Oxygen we obtain from rocks, air, water, fluids, and very many different compounds, and also from rocks of all geological ages, from the Tertiary to the Silurian or the Azoic; and if through this vast extent of time,

millions upon millions of years, any change was effected in its properties the specimens would manifest it. Hydrogen is procured from coal, water, etc. Two litres of any specimen of hydrogen will combine with one litre precisely of any specimen of oxygen, and will form two litres of the vapor of water. If by lying in rocks, through all the geological epochs of the past, passing through the volcanic and heat changes to which the rock is subject, or in space, dashing along as comets and meteors of which it is space, of which it is part and parcel, if any change or modification in the molecules had occurred, these relations of oxygen and hydrogen above mentioned, would no longer exist; but the same proportion of combination between these two elements exists to-day as millions of years ago, showing that the individuality or identity of the molecule is preserved.

"The spectroscopist finds through the spectroscope that the molecules of hydrogen are the same not only in the sun, 92,500,000 miles away, but in the fixed stars, Arcturus, Sirius, Aldebaran, etc., trillions of miles distant. The molecule is indestructible; it preserves its identity through all time. Each molecule throughout the universe possesses the same size and form. A molecule of iron, or aught else, is the same in the dog-star as on the earth, preserving its

individuality; it cannot grow or decay; the molecule is incapable of generation or destruction. Though planets may be destroyed, and new systems develop, the molecules remain unchanged, unbroken and unworn, the same in size, in weight and shape." Each molecule is as much in a world by itself as each individual man; and as much space exists between each molecule in which the forces can move them about in proportion to their size, as between bees in a swarm; consequently if we analyze a drop of water, or, rather, could we reduce it to its minimum or smallest size, a molecule, we should find that, instead of its losing its identity and becoming lost in the great ocean mass, it preserves its individuality and moves about in its own little orbit. The unseen world is comparatively as great and wonderful upon our planet as beyond, as the microscope long ago revealed.

Now, if the lowest condition to which matter can be reduced, the atom or the molecule (the former being the smallest division of a single element, and the latter the minutest division of a compound) preserves its individuality or identity under all conditions and through all time, and also pervades all space, whether in the solid, liquid, or gaseous form, is it any less probable that the universal life or spirit-force pervading the universe, divided and dwelling in innum-

erable individual forms, will preserve its identity through whatever changes the mass of matter with which it is connected may pass through? To be sure, the material body of a man dies, the form is not preserved or individualized, but the atoms or molecules of which it is made up remain the same, retaining their constant individual form and shape; and the life or spirit which builds them up and holds them together in the form of man, when it loosens its hold and escapes, can it be any less individualized than the atoms or molecules which it partially controls? An army, for example, is made up of individuals; they move collectively as one body. Take the "army of the Potomac;" they moved in one solid phalanx, united in one single purpose, and imbued with one and the same spirit of love and defence of their country. At the close of the war this body or army decomposes, so to speak, falls to pieces, or scatters into its original individual elements of men; as they return to their respective homes the army as a body is no more, but the spirit that moved them through the fields of blood in the defence of their native land still lives, and will continue to live, as an individual part of the nation's struggle for existence.

The life or spirit force that moves our being cannot be seen any more than can heat or electric-

ity; we can only see or feel its effects; if it is material—something that we could feel, see, smell, taste or hear—the evidence would be positive and beyond question; but as we cannot taste, smell, see, hear or handle it, as our experiences and observations are so entirely confined to matter, it is not surprising that we are totally unable to comprehend it through our material senses, for these are the only channels through which we can arrive at positive and substantial conclusion; hence the question *of the end of man* must always remain more or less unsettled while spirit and matter continue two distinct elements. We know, however, as Mr. Moody suggests, that mind or spirit in many instances works independently of matter. The material body of man changes, or wastes away, the physiologist tells us, once in seven years; not one particle of his body, in any form, remains at the end of that time. The change is very gradual, the waste of the entire body is constant; and it is to supply this great waste that we are obliged to eat, and a new body is constantly, and as gradually filling the place of the old, as the latter is wearing and wasting away. Like the petrifying process of wood before described, a strip of it lies in a limestone region, the wood slowly wastes away, and as rapidly as a particle, an infinitesimal particle, drops, lime works in, hardens and fills the place,

and thus as particle after particle of the wood is wasting, new matter as gradually fills in, and, so slow is the process, the form of the fibers and tissues of the wood is preserved, as the form of a scar upon a man's body is preserved, through the same slow process; not a particle of the strip of wood remains; it is petrified, or, the entire waste of the wood is substituted by limestone.

Now the fact is significant that, as every molecule or particle of the body wastes or returns to the earth in seven years, why, if the mind or spirit is not entirely independent of the body, and does not preserve its individuality or identity apart from matter, does not consciousness or memory, which is part and parcel of the mind, waste away with the body in seven years? But, on the contrary, the octogenarian is more conscious of events that occurred seventy years ago, or in the days of his childhood—can remember them with greater ease—than events that occurred within the space of seven years of his advanced age.

What is true of man, *may* be true of all animal creation. I do not say it *is* true, but a possibility exists; and I may go a step farther and say, a probability in advanced types in a far less degree. And what is true of the earth is undoubtedly true of all beings inhabiting the planets and stars throughout the universe, capable of support-

ing life. And it is possible, (I do not say probable), that inhabitants of other planets and stars are as far beyond man in intellectual, spiritual and stellar development, as is man upon our planet ahead of the quadramana. The conditions of other planets and stars for development, may be at variance with the conditions of the earth, but the revelations of the spectroscope exhibit nearly the same material constituents as our own; hence it is useless to speculate upon a different order of beings in other portions of the universe. Sufficient it is to say, that man is the highest manifestation of any type known to us.

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